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Air Route Surveillance Radar Model 4 (ARSR-4) Operational Test and Evaluation (OT&E) Final Report

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May 1997

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16. Abstract

The Air Route Surveillance Radar Model 4 (ARSR-4) is a state-of-the-art, three-dimensional, long-range radar. The system is being jointly procured by the Federal Aviation Administration (FAA) and the U.S. military. This radar will replace aging height-finding and long-range two-dimensional air search radars which are currently in use. Forty-four ARSR-4 systems are scheduled for installation around the coastal United States and in Hawaii, Guam, and Guantanamo Bay, Cuba.

This report presents the results of the Operational Test and Evaluation (OT&E) of the ARSR-4 radar system. OT&E Integration and Operational tests were conducted in accordance with FAA Order 1810.4B to verify that the ARSR-4 is operationally suitable and effective and can meet operational requirements when integrated into the National Airspace System (NAS).

Test results revealed that the ARSR-4 performs most basic functions well. Improved coverage was noted in areas with a history of poor coverage. Results also revealed that the ARSR-4 can process and provide message outputs for a capacity load within the primary coverage area. Controller comments were generally favorable although several problems were identified during testing.

The ARSR-4 at Mt. Laguna had a significantly higher beacon split rate than the ARSR-3. The ARSR-4 did not perform reliably during the test period. The number of critical operational problems encountered was excessive. The ARSR-4 did not consistently recover from a short-term power loss. Several power related problems were discovered. Problems were also discovered with the ARSR-4 Built-in Test (BIT) and Fault Isolation Test (FIT) functions and resolution algorithms.

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EXECUTIVE SUMMARY

This report presents the results of the Operational Test and Evaluation (OT&E) of the Air Route Surveillance Radar Model 4 (ARSR-4) radar system at Mt. Laguna, California. The tests were conducted from May 23, 1994, through January 15, 1995 (using multiple software builds), and from June 1, 1995, through August 11, 1995 (using 25MAY95 and 13JUN95 software builds).

OT&E Integration and OT&E Operational tests were conducted in accordance with Federal Aviation Administration (FAA) Order 1810.4B to verify that the ARSR-4 is operationally suitable and effective and can meet operational requirements when integrated into the Nation Airspace System (NAS). OT&E Integration tested the ARSR-4 interfaces with other NAS subsystems and the end-to-end performance of the ARSR-4 when operated in NAS. These performance tests were designed to verify that the ARSR-4 meets both NAS-SS-1000 and ARSR-4 system requirements. OT&E Operational tests measured the suitability and effectiveness of the ARSR-4 operating in NAS.

Test results revealed that the ARSR-4 performs most basic surveillance functions well. Improved ARSR-4 coverage (when compared to ARSR-3 coverage) was noted, especially in areas with a history of poor coverage. Results also revealed that the ARSR-4 can process and provide message outputs for a steady state capacity load of 800 aircraft returns within the primary radar coverage area in the Air Traffic Control Beacon Interrogator (ATCBI) configuration.

Controller comments were generally favorable although several problems were identified during testing. The problems, along with ACT-310 recommendations, are presented in the following paragraphs. The "Current Status": of each problem is presented by AND-440 and reflects the efforts of AND-440, AOS-230, and Northrup Grumman, after the completion of OT&E, to resolve the problems that were identified.

The ARSR-4 at Mt. Laguna had a significantly higher beacon split rate than the ARSR-3. The higher split rate often exceeded Quick Analysis of Radar Sites (QARS) tolerances which were used to certify the radar in NAS. The cause for the high split rate at Mt. Laguna should be identified and corrected.

<u>Current Status</u>: *The primary cause of the higher beacon split rate was due to a beacon target centroiding problem that was corrected in the 5FEB96 software build for the ARSR-4. The installation of this software and the additional optimization of the system by AOS-230 has corrected the beacon split rate to a level within acceptable tolerances. The ARSR-4 at Mt. Laguna was commissioned on 3JUL96 following the correction of this problem and the successful retesting. Through the utilization of this new software and additional optimization procedures developed by AOS-230, 13 additional ARSR-4s have been commissioned without a problem with the beacon split rate.*

The ARSR-4 did not perform reliably during the test period. The number of critical operational problems encountered was excessive. Several significant problems remained in the system at the conclusion of OT&E. First, a "beacon strobe" problem (the reporting of all beacon targets at the same azimuth) was encountered during the certification flight check. The problem was identified as a serious operational problem by controllers. Second, the ARSR-4 was unable to automatically restore

a faulted or standby Central Processing Unit (CPU) to on-line status. A system reset (up to a 3-minute outage) was needed to restore faulted CPUs. These known problems which contribute to poor ARSR-4 reliability should be addressed immediately. Additional reliability assessments should be made after the system has run for a time with a controlled hardware and software configuration.

<u>Current Status</u>: The "beacon strobe" problem was corrected by the contractor in the 8AUG95 software build and that correction is in every build installed in all ARSR-4 systems. Subsequent factory benchmark and additional site testing by AOS-230 has proven that this fix has corrected the problem. The faulted/standby CPU not returning to the mix during a warmstart was corrected tested in the 11SEP96 build. In addition following the completion of the OT&E, a reliability analysis study has completed demonstrating that the ARSR-4 system has met the reliability requirements in the contract. The study included failure data from all of the ARSR-4 systems installed for a year after the tenth system was installed and included 26 systems. Further analysis of the commissioned ARSR-4s (14 to date) demonstrate that the ARSR-4 system is exceeding the availability requirements of the NAS.

Operational problems were introduced into the ARSR-4 when new software builds were installed during OT&E. This points to insufficient software testing at the factory. The ineffective software testing had an adverse effect on ARSR-4 reliability during OT&E. New software builds should be fully tested at the factory and at a test site prior to reaching the end users in the field.

<u>Current Status</u>: Based on this recommendation, a software configuration control and testing plan was developed in cooperation with ACT-310, AOS-230, and AND-440 to insure that no new problems were introduced as new software builds were produced by the contractor. The plan includes a review of the proposed changes and factory benchmark testing plus testing at other installed sites prior to installation in an operational or commissioned system. The plan has been implemented and has been used on all new software builds.

The ARSR-4, as configured at Mt. Laguna, did not consistently recover from a short-term power loss (less than 15 seconds). The ARSR-4 should be operated with an Uninterruptable Power Supply (UPS) in addition to a reliable backup engine generator in order to avoid most of the power related problems described in this report.

<u>Current Status</u>: The contractor has made software changes, hardware corrections, and maintenance procedural changes in an effort to insure that the ARSR-4 meets the requirements for recovery from short-term power loss. Due to the importance of this issue, AND-440 agreed with this recommendation and as part of the ARSR-4 Deployment Decision, all ARSR-4s will be installed and operated with an UPS in addition to a reliable backup engine generator prior to system commissioning into the NAS. AND-440 has provided the funding for the UPS systems at all ARSR-4s.

ARSR-4 Built-In Test (BIT) and Fault Isolation Test (FIT) features detected and isolated most of the faults injected into the system during the test period. However, serious failures on several boards in the Data Processor were not automatically detected. This indicates that not all possible faults were injected into the system during testing. The level of BIT/FIT effectiveness in detecting/isolating problems with faulted boards is unknown. In addition, BIT does not monitor the status of backup battery voltages in the Signal Processor and Data Processor. Data can be lost to the user if the ARSR-4 experiences a power loss while the backup batteries are faulty or uncharged. ARSR-4 BIT/FIT should not be used as the only means to maintain the system. An alternate plan (such as troubleshooting flowcharts) should be developed to assist the radar technician in troubleshooting problems when BIT/FIT do not detect or isolate faults.

Current Status: The contractor has developed and delivered a generic trouble shooting procedure for failures in the system that have not been detected and isolated by BIT/FIT. In addition, the contractor has delivered a list of the possible 2 percent of items in the ARSR-4 that cannot be detected by BIT. These documents have been delivered to AOS-230 for review and comment. These two documents and the ARSR-4 technical instruction books on site will provide enough information to perform corrective maintenance on the system for the Independent Operational Test and Evaluation (IOT&E) period. All of the documents identified above are being reviewed and redlined to optimize the corrective maintenance of the system. These procedures have been presented to AOS-230 for concurrence. The contractor has continued to make improvements for those faults not detected in the IOT&E baseline software build, to fine tune the critical parameters which govern the BIT's capability to detect failures for specific areas of the ARSR-4 identified as problems during the ACT/AOS testing at Mt. Laguna. Those changes have been included in the 11SEP96 software build which has completed the benchmark and first site field testing and is installed in one commissioned ARSR-4.

The available spare memory in the ARSR-4 at the end of OT&E will not be sufficient to support future system corrections or upgrades. The spare memory should be increased to support system upgrades, future system expansion, or corrections for any future problems.

Current Status: A contract modification was executed in December of 1996, and the critical design review was held on March 19, 1997, for the contractor to develop a prototype modification to the ARSR-4 system design to add 25 percent spare memory. The modifications will include hardware and software upgrades to be completed by November 1997. Following successful testing of the prototype another contract modification with FY98 money will be executed to install the spare memory increase in all 44 ARSR-4s.

The ARSR-4 met the 2.2-square meter primary range and azimuth resolution requirements (50 percent requirement). However, the ARSR-4 failed the 10-square meter primary range and azimuth resolution tests (a more stringent, 90-percent requirement). Test results revealed a resolution "hole" which indicates a problem in the ARSR-4 resolution algorithms. The operational significance of the range resolution hole (between 1/8 nautical mile (nm) and 1/4 nm) should be evaluated by Air Traffic (AT) personnel.

Current Status: The ARSR-4's search resolution performance will not have an effect on the operational performance of the FAA or Air Force, and their ability to maintain the required operational separation between aircraft. This issue has been discussed in detail with ATR-110 and based on those discussions and a review of SR-1000, a decision has been made that the search resolution problems seen during the OT&E testing will not have an operational impact in the enroute environment. This has been confirmed by the fact that no operational issues have been seen by the AT community relating to the search resolution from the data utilized from the 14 commissioned ARSR-4s. The Air Force conducted additional resolution flight tests for the ARSR-4 to verify the separate Air Force requirements. The Air Force requirements use two 2.2-square meter targets and the resolution requirement is set at 50 percent. The ARSR-4 exceeded the requirements for the Air Force.

The ARSR-4 weather detection and reporting capability was not fully evaluated at Mt. Laguna due to the unavailability of significant weather in the area. However, one problem was identified in the weather presentation on the controllers; displays at the Los Angeles Center. The Direct Access Radar Channel (DARC) system displays ARSR-4 weather information differently than the HOST. The inconsistent weather processing between Air Route Traffic Control Center (ARTCC) computers is not suitable for air traffic control (ATC). DARC weather processing should be corrected so that consistent weather information is reported to the controller when the backup system is switched on-line.

Current Status: Two problems contributed to this problem. The first was that NAS Change Proposal (NCP) TR230-CPF-022 modified the display of weather in the NAS so that high level weather is now displayed in addition to the medium and low level weather. Previously, NAS discarded high level weather. The DARC software at the time of the OT&E was not modified to display the high level weather. Therefore, the ARSR-4 weather data was displayed differently on the NAS and DARC systems. The controllers saw the same symbols on both systems but the symbols will have different meanings. The DARC software was modified to correspond to the requirements of the NCP, but the changes were not implemented prior to the completion of the OT&E. The DARC software changes were implemented prior to the commissioning of the ARSR-4 at Mt. Laguna in June of 1996.

A second problem dealt with the weather data being sent from the ARSR-4 system at a rate higher than the HOST system limitation required by the Computer Display Channel (CDC) but the DARC could process the data at the higher rate. Sometimes weather data from the ARSR-4 was displayed by the DARC and not through the HOST processing path. Changes to the ARSR-4 software were required to correct the problem. This software correction was completed by the contractor, implemented in the 5FEB96 software build, and passed the benchmark testing prior to installation in the ARSR-4 systems. This change is included in the software in all commissioned ARSR-4s.

The ARSR-4 design allows the system to be optimized, adapted to site conditions, and certified. However, during OT&E, the ARSR-4 output false weather to the user when anomalous propagation (AP) conditions were prevalent. This indicates a limitation in the ability of the ARSR-4 to automatically adapt to some changing environmental conditions. The impact of false weather caused by AP should be evaluated at each site. If the false weather is more severe at other locations, causing operational problems, steps (either through procedural changes or redesign) should be taken to ensure that the ARSR-4 can automatically adapt to these environmental conditions.

Current Status: To address this issue an AP Working Group has been formed with AOS-230 as the lead, and members from Air Force RADES, ARSR-4 contractor, regional representatives, MITRE, and AND-440. The purpose of the group was to analyze the problem in further detail now that there are several ARSR-4s in operation and develop a solution that would be tailored to the specific AP conditions of a particular site. The intent is to maximize the capabilities already built into the current ARSR-4 design prior to developing design modifications that will be implemented by AOS-230. The work is still in progress.

The ARSR-4 to ARTCC interface operates effectively. The ARSR-4, however, will not interface effectively with the Mode Select Beacon System (Mode S) or the Radar Remote Weather Display System (RRWDS). Proper operation of these interfaces requires further design changes to the ARSR-4. Additional testing is recommended for these interfaces after the problems are corrected.

Current Status: A contract modification has been executed with the Mode S contract to complete the development of the ARSR-4 to Mode S interface. Based on the proposed design of the interface only a small hardware modification to the ARSR-4 will be required. Significant changes to the Mode S system will be required. The prototype design will completed by December 1997. Currently there are no ARSR-4s planned to be installed with a Mode S.

AOS-230 has volunteered to develop and implement the correction to the RRWDS interface problems. The changes were made on the RRWDS side of the interface and was implemented the week of August 14, 1995, on the Mt. Laguna system, and verified during the IOT&E period. The modifications to the other RRWDS will be implemented by AOS-230. AOS-230 will fully test the modification to the interface prior to its

implementation. The implementation of these modifications at all ARSR-4/RRWDS sites will occur following the installation of the ARSR-4s. Currently, the RRWDS is not critical to the operation of the FAA, Air Force, or Customs Service and is not a certifiable piece of equipment but provides data to the National Weather Service(NWS).

1. INTRODUCTION.

1.1 PURPOSE.

This report presents the results of the Operational Test and Evaluation (OT&E) of the Air Route Surveillance Radar Model 4 (ARSR-4) radar system. OT&E Integration and Operational tests were conducted in accordance with Federal Aviation Administration (FAA) Order 1810.4B to verify that the ARSR-4 is operationally suitable and effective and can meet operational requirements when integrated into the National Airspace System (NAS).

1.2 SCOPE.

This report discusses the results of the OT&E Integration and Operational tests performed on the ARSR-4 from May 23, 1994, through August 14, 1995. The first phase of OT&E was conducted on the ARSR-4 at Mt. Laguna, California, from May 23, 1994, through November 1, 1994. The discovery of significant problems during that period led to regression testing after the identified problems were fixed. OT&E regression tests were conducted from June 5, 1995, through August 14, 1995.

2. DOCUMENTS.

FAA-E-2763b	ARSR-4 Radar System Specification, May 6,1988
NAS-SS-1000	NAS System Specification, Vol. I, II, III, and V, December 1986
NAS-MD-110	Test and Evaluation Terms and Definitions for the NAS, March 27,1987
ORDER 1810.4B	FAA NAS Test and Evaluation Policy, October 17, 1991
	ARSR-4 Interface Control Documents
	ARSR-4 Operational Test and Evaluation Plan, June 14, 1994.
	ARSR-4 Test Procedures, February 27, 1990
	ARSR-4 Technical Instruction Books, Westinghouse Electric Corporation, Baltimore, Maryland

3. SYSTEM DESCRIPTION.

3.1 MISSION REVIEW.

The ARSR-4 is a three-dimensional, state-of-the-art, all solid-state radar system being jointly procured by the FAA and United States Air Force (USAF). The ARSR-4 system will replace existing ARSR-1 and ARSR-2 radar systems and establish radar coverage at new locations.

The primary mission of the ARSR-4 is to provide high quality, primary digital radar data on aircraft positions to the Air Route Traffic Control Center (ARTCC) and to the Sector Operations Control Center (SOCC) and Fleet Area Control Surveillance Facility (FACSFAC). When interfaced with an Air Traffic Control Beacon Interrogator (ATCBI) or Mode Select Beacon System (Mode S), the ARSR-4 will also provide secondary radar (beacon) data on transponder equipped aircraft.

The secondary mission of the ARSR-4 is to detect and report weather within the coverage area in National Weather Service (NWS) six level format.

Detailed operational characteristics for the ARSR-4 are defined in the FAA operational requirements document (ORD). The key operational characteristics are:

a. Coverage. The coverage volume of the ARSR-4 extends from 5 to 250 nautical miles (nm) for 360° and from the radar line of site (RLS) to 100,000 feet above ground level (AGL) to 30° in elevation. A lookdown beam detects targets to -7° below the radar horizon. The ARSR-4 must detect a 2.2 square meter radar cross section (RCS) target within this volume at any range less than 200 nm with a probability of 80 percent or greater.

b. False Reports. The ARSR-4 is required to operate in all clutter environments with minimal degradation in detection and no more than 194 false target reports per scan.

c. Positional Accuracy. The ARSR-4 required primary radar positional accuracy is 1/16 nm route mean squared (rms) in range, 2 Azimuth Change Pulses (ACPs) rms in azimuth and 3000 feet rms in height (within 200 nm). The required beacon positional accuracy is 1/32 nm rms in range for stationary targets, 1/16 nm rms in range for moving targets, 2 ACPs RMS in azimuth, and within 125 feet in height with 95 percent probability.

d. Resolution. The ARSR-4 must resolve two closely spaced aircraft at least 90 percent of the time when separated by 1/8 nm or greater in range and/or 2.0° or greater in azimuth.

e. Weather Detection. The ARSR-4 will detect five weather levels within the coverage volume with minimal degradation from ground clutter and second time around weather.

f. Remote Monitoring. The ARSR-4 will provide remote monitoring, control, and diagnostic capability through Remote Maintenance Monitoring System (RMMS).

g. Operational Availability. The ARSR-4 operational availability will be at least 0.99742. The ARSR-4 will be operable and maintainable with the currently available work force and skill levels and require minimal periodic maintenance visits.

h. Site Adaptation and Optimization. The ARSR-4 will be site adaptable using a well defined and efficient procedure. ARSR-4 will require minimal readjustment or parameter optimization to compensate for environmental and seasonal changes.

3.2 TEST SYSTEM CONFIGURATION.

The ARSR-4 was collocated with an ARSR-3 radar at Mt. Laguna during OT&E. To avoid mutual interference between radars, the ARSR-3 transmitter was blanked in the direction of the ARSR-4 and the ARSR-4 transmitter was blanked in the direction of the ARSR-3 (from 326° to 360° in azimuth).

The ARSR-3 operated in simplex mode on channel B to avoid interfering with ARSR-4 operation. The ARSR-3 operated in diplex only when requested by controllers (usually to provide better ARSR-3 weather products). No ARSR-4 testing could be conducted with the ARSR-3 in diplex due to the severe interference.

A beacon blanker was installed on the ATCBI-5 to interrupt triggers to the ARSR-4 in the area from 330° to 360°, effectively blanking beacon operation in that region. Later, a military map was configured in the ARSR-4 to accomplish the same task.

The ARSR-4 at Mt. Laguna was configured with no lookdown capability. The ARSR-4 operated in Variable Interpulse Period (VIP1) mode for most of the tests. The Auto Reconfiguration and Auto Transmit features were enabled for most tests.

Numerous software builds were installed in the Mt. Laguna ARSR-4 during testing. Those builds are listed in table 3.2-1. The first phase of OT&E began on May 18, 1994, using the 05MAY94 software build and extended through November 1, 1994, using the 06SEP94 build. Those builds installed between November 1, 1994, and May 16, 1994, were interim builds which addressed problems identified during the first phase of OT&E.

OT&E regression tests were started on the 25MAY95 software build. However, problems identified in that build required further fixes. On July 8, 1995, the 13JUN95 build, which contained the required fixes, was installed and used for the remainder of OT&E.

TABLE 3.2-1. SOFTWARE BUILDS INSTALLED DURING OT&E

Software Build	Installation Date
03MAY94	May 18, 1994
28JUN94	Jul 24, 1994
10AUG94	Sep 02, 1994
06SEP94	Oct 11, 1994
28OCT94	Nov 01, 1994
03NOV94	Nov 13, 1994
22NOV94	Dec 08, 1994
21DEC94	Jan 30, 1995
23FEB95	Mar 08, 1995
07MAR95	Mar 13, 1995
28MAR95	Apr 06, 1995
07APR95	Apr 08, 1995
17APR95	Apr 19, 1995
05MAY95	May 09, 1995
12MAY95	May 16, 1995
25MAY95	May 26, 1995
13JUN95	Jul 08, 1995

3.3 INTERFACES.

The ARSR-4 will interface with the existing and planned NAS equipment listed in table 3.3-1. This table indicates whether the actual interfaces were available for test, whether the interface was simulated, or whether the testing was deferred due to unavailability of equipment.

TABLE 3.3-1. ARSR-4 INTERFACES

Interface	OT&E Status
ATCBI-5	Actual
Mode S	Simulated/Deferred
RRWDS	Actual
ARTCC/HOST/DARC	Actual
En Route Automated Radar Tracking System (EARTS) and Microprocessor EARTS (MicroEARTS)	Deferred
SOCC/FACSFAC	Actual
RMMS	Actual

As shown in table 3.3-1, the tests performed on each interface except the Mode S, Enroute Automated Radar Tracking System (EARTS), and the Microprocessor-based Enroute Automated Radar Tracking System (MicroEARTS) were performed with the actual equipment. Because the Mode S was not available at Mt. Laguna during OT&E, tests of the interface were limited to document review and ARSR-4 status message inspection using a protocol analyzer to simulate the Mode S. Since these tests did not test the end-to-end performance of the interface, the majority of ARSR-4/Mode S integration tests were deferred until the Mode S is available.

Tests of the ARSR-4 to EARTS and ARSR-4 to MicroEARTS interfaces have not yet been performed due to the unavailability of the equipment at the Los Angeles ARTCC. The first ARSR-4 site scheduled to interface with a MicroEARTS is in Mt. Santa Rosa, Guam. The first ARSR-4 site scheduled to interface with an EARTS is in Mt. Kaala, HI. These interface tests will be deferred until the ARSR-4 is installed at each of these sites.

3.4 OT&E DESCRIPTION.

OT&E was divided into Integration, Operational, and Shakedown tests. OT&E Integration tests evaluate the NAS end-to-end performance with the ARSR-4 included as part of NAS. These tests include the ARSR-4 interfaces and specification related performance tests.

OT&E Operational tests evaluate the effectiveness and suitability of the ARSR-4 when integrated into NAS. User input is provided by air traffic controllers and the reliability, maintainability, and availability of the ARSR-4 is assessed.

3.4.1 Test Schedule and Locations.

OT&E Operational and Integration tests were performed at the Mt. Laguna, CA, radar site and at the Los Angeles ARTCC.

Mt Laguna was chosen as the test site due to a challenging environment with a combination of land (mountains) and sea clutter. The site is located approximately 50 miles east of San Diego and has an elevation of 6238 feet above Mean Sea Level (MSL). The ARSR-4 will replace the ARSR-3 radar presently operating at Mt. Laguna.

The Mt. Laguna ARSR-4 transmitted radar data to the Los Angeles ARTCC located in Palmdale, CA. The ARSR-4 was adapted as a new radar which allowed the data to be switched into the HOST computer system or Direct Access Radar Channel (DARC).

3.4.2 Participants.

ACT-310 provided overall management for the test program through the Associate Program Manager for Test (APMT). In addition, ACT-310 personnel conducted OT&E Integration and OT&E Operational tests with support from Western Pacific region, the Los Angeles ARTCC, and Mt. Laguna site personnel. AOS-230 and the Air Force's 84th Radar Evaluation Squadron (RADES) worked together to optimize the Mt. Laguna ARSR-4. In addition, both organizations worked together during the OT&E Shakedown phase of testing. ACT-330 conducted OT&E Integration tests on the ARSR-4 to RMMS. Table 3.4.2-1 lists the organizations involved in OT&E along with the responsibility of each organization.

TABLE 3.4.2-1. ARSR-4 OT&E RESPONSIBILITIES

Organization	Responsibility
FAA Technical Center, ACT-310	OT&E Integration and OT&E Operational
FAA Aeronautical Center, AOS-230	OT&E Shakedown and Optimization
FAA Technical Center, ACT-330	RMS and RMMS testing
84th Radar Evaluation Squadron	Optimization and OT&E shakedown support

3.4.3 Test Objectives/Criteria.

OT&E verifies that the ARSR-4 meets all operational requirements, resolves all critical issues, and integrates effectively with other components in NAS. From the operational requirements, the following major operational issues were identified for test:

a. Coverage Does the ARSR-4 provide the air traffic controller with suitable primary and secondary radar data within the required coverage volume which allows the controller to monitor flight progress, identify violations of airspace restrictions and potential conflict situations, and maintain separation standards?

b. False Alarm Rate Does the number and distribution of false reports from the ARSR-4 allow reliable aircraft detection, identification, and tracking consistent with the air traffic control (ATC) mission and airspace safety requirements?

c. Site Adaptation and Optimization Does the system design and procedures allow the radar system to be optimized, adapted to site conditions, and certified in a reasonable time by available maintenance personnel? Is the time before reoptimization consistent with the maintenance philosophy?

d. Aircraft Separation Does the radar detect closely spaced aircraft with sufficient reliability to allow the controller to maintain separation standards?

e. Reliability, Maintainability, and Availability Is the reliability, maintainability, and availability of the ARSR-4 suitable for incorporation into the NAS when used in an operational environment with the available resources, logistics plan, maintenance procedures, and personnel?

f. NAS Interoperability Does the ARSR-4 operate effectively within the NAS including the following issues:

1. Compatibility with other site equipment,
2. Equipment interface,
3. Data and signal quality,
4. Data capacity and delay?

g. Primary Power Requirements Does the system operate within the voltage tolerance envelope encountered on site?

h. Weather Detection and Display Does the ARSR-4 provide accurate and reliable weather data suitable for safe aircraft routing by ATC?

i. Safety Is the ARSR-4 safe to operate?

4. TEST AND EVALUATION.

4.1 OT&E INTEGRATION TESTS.

OT&E Integration measured the end-to-end performance of the ARSR-4 in NAS. Performance and interface capabilities were tested to ensure that the ARSR-4 provides accurate data in a reliable manner to the end user.

4.1.1 Surveillance to ARTCC.

These tests verify that the ARSR-4 reliably transmits data in the proper format to the ARTCC with sufficient built-in test capability to detect degraded performance.

4.1.1.1 User Port Operation.

Purpose
Ensure that the ARSR-4 can physically and functionally interface to user modems.

Test Objectives

a. Verify that the ARSR-4 user ports can be configured to support individual user requirements.

b. Verify that five of the ports are adjustable to EIA-RS-232 and/or EIA-RS-530, nine are EIA-RS-232 compatible, and six (military ports) are EIA-RS-530 compatible.

c. Verify that the clock and data electrical characteristics and timing are in compliance with EIA-RS-232 and EIA-RS-530 standards at varying signaling rates.

d. Verify that there is sufficient redundancy in the ARSR-4 to reconfigure standby Serial Input/Output (SIO) ports to on-line when a communications failure is encountered.

Test Description
The ARSR-4 communicates with the modems via the Input/Output (I/O) subsystem in the data processor. Eight SIO boards, each containing four serial ports, provide data to the user (a ninth SIO board is used as a spare). Of the four serial ports, port 0 is software configurable to RS-232 or RS-530/RS-422, port 1 is configured for RS-232 operation, and ports 2 and 3 are configured for RS-530/RS-422 operation.

Table 4.1.1.1-1 shows the I/O subsystem configuration for Mt. Laguna. The table includes the SIO board, serial port, electrical protocol, and physical jack assignments in the Radar Cable Junction Box (RCJB) for each user port. As seen in the table, the ARSR-4 provides 20 user ports (AF1-AF6, and P1-P14).

TABLE 4.1.1.1-1. ARSR-4 COMMUNICATIONS PORT ASSIGNMENTS

User Port Designation	SIO Board	Serial Port	Electrical Protocol	RCJB Jack
AF1	1	3	RS-530	J28
AF2	3	3	RS-530	J29
AF3	4	3	RS-530	J30
AF4	5	3	RS-530	J35
AF5	6	3	RS-530	J36
AF6	8	3	RS-530	J37
P1	1	0	RS-232	J48
	1	0	RS-530	J49
P2	2	0	RS-232	J50
	2	0	RS-530	J51
P3	6	0	RS-232	J55
	6	0	RS-530	J56
P4	4	0	RS-232	J57
	4	0	RS-530	J58
P5	5	0	RS-232	J69
	5	0	RS-530	J70
P6	3	1	RS-232	J72
P7	2	1	RS-232	J71
P8	4	1	RS-232	J76
P9	5	1	RS-232	J77
P10	3	0	RS-232	J78
P11	1	1	RS-232	J79
P12	6	1	RS-232	J90
P13	7	1	RS-232	J91
P14	8	1	RS-232	J92

Pulse characteristics measurements were made at the jacks in the RCJB using an Hewlett Packard 54510A oscilloscope. Channel one of the oscilloscope was used to measure data signal characteristics (i.e., voltages, pulse widths, rise times, fall times) while channel two measured clock signal characteristics. The two channels were compared to ensure that data levels transitioned on the correct edge of the clock and that setup and hold times were being observed. The measurements were repeated for both RS-232 and RS-530 ports operating at various baud rates.

Action was taken at the local display console (LDC)/Remote Monitoring Subsystem (RMS) to configure from one to four user ports for each user. In addition, the spare SIO board was switched on-line to verify redundant operation.

Results

The ARSR-4 provides sufficient flexibility to configure the communications ports to support FAA and USAF requirements. The ARSR-4 provides 20 user ports to interface with up to 20 users. Up to four ports can be assigned to any individual user. Six user ports are dedicated to military users and communicate via the RS-530 standard. The remaining 14 user ports are joint

FAA/Military ports and are configured for RS-232. Five of the 14 joint user ports can be software configured for RS-232 or RS-530 operation.

Oscilloscope measurements showed that the clock and data voltages, pulse widths, and rise and fall times were in compliance with EIA-RS-232 or EIA-RS-530 standards at the various available baud rates. Data transitioned on the correct edge of the clock.

The spare SIO board can be switched on-line via RMS control of the A/B switch and can replace any of the remaining eight SIO boards. The output of the A/B switch is cabled directly to jacks on the RCJB. The test of the automatic switch of the spare SIO board for a faulted SIO is described in the Degraded Operations section to follow.

Conclusions

a. Sufficient flexibility exists to assign one to four serial ports to each FAA or USAF user.

b. The serial ports transmit data with correct timing and pulse characteristics to the modems.

c. The spare SIO board can be manually switched on-line to replace a failed SIO.

4.1.1.2 Data Formats.

Purpose

Ensure that the ARSR-4 reliably transmits all expected message types to the ARTCC with the correct bit formatting.

Test Objectives

a. Verify that the ARSR-4 outputs messages in the correct Common Digitizer 2 (CD-2) format to the ARTCC.

b. Verify that the ARSR-4 consistently reports beacon and search Real-Time Quality Control (RTQCs) and status messages to the user on each scan.

c. Verify that the ARSR-4 can detect, process, and report civil and military beacon emergencies in the proper format.

d. Verify that changes in ARSR-4 status are detected and accurately reported in the status messages sent to the ARTCC.

e. Verify that the status reported in the CD-2 status message is consistent with beacon environmental RMS status.

Test Description

An Integrated Radar Evaluation System (IRES) recorder collected data on the ARSR-4 user 1 (AF1 and AF2) ports. The formatter was configured to output ARTCC CD-2 messages. Data sources included targets of opportunity, beacon test targets, or data collected while the ARSR-4 status was modified.

Target of opportunity data was recorded to verify that the ARSR-4 outputs each message type in the correct format. The data was also analyzed to ensure that beacon RTQCs, search RTQCs and status messages were output to the user on each scan.

Beacon replies were injected at Radio Frequency (RF) into the ATCBI-5 to verify that beacon bits in the ARSR-4 CD-2 message operated as expected and that the ARSR-4 properly processed beacon emergency replies.

The test configuration is shown in figure 4.1.1.2-1. A Sensis Video Beacon Interrogator Test Set (VideoBITS) modulated the RF generator of a UPM-155 beacon test set. The replies, at RF, were then injected into the ATCBI-5. CD data was recorded at the ARSR-4 output using IRES.

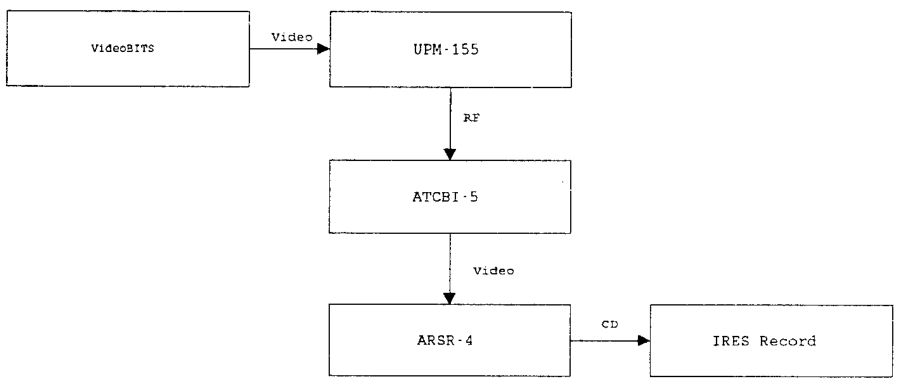

FIGURE 4.1.1.2-1. BEACON TEST TARGET CONFIGURATION

The beacon test target scenarios used for this test are shown in table 4.1.1.2-1. DETECT06.SET and DETECT08.SET each contained 12 test targets. The test targets were injected at various ranges and azimuths. Mode 3/A and Mode 2 codes were chosen to exercise all bits in those fields in the CD-2 message. Target altitude was varied from 0 to 110,000 feet to test the Mode C field in the message.

For each scenario, the round reliability was set to 76 percent, where round reliability is a measure of the aircraft's probability of responding to a particular interrogation. This probability is less than unity due to aircraft maneuvers, transponder dead time because of another interrogation, and transponder lockout because of an excessive number of interrogations.

TABLE 4.1.1.2-1. BEACON TEST TARGET SCENARIOS

<table>
<tr><th>Scenario</th><th>Description</th></tr>
<tr><td>DETECT06.SET</td><td>12 individual targets with range movement. All runlengths = 31 ACPs. Replies to Modes 3/A, 2, C interrogations. No azimuth movement. Round Reliability = 76%.
<table>
<tr><th>Target</th><th>Start Range (nm)</th><th>Start Azim. (deg)</th><th>Range Movement (nm/hr)</th><th>M3 Code</th><th>M2 Code</th><th>MC Code</th></tr>
<tr><td>1</td><td>30</td><td>5</td><td>600</td><td>7776</td><td>0001</td><td>5230</td></tr>
<tr><td>2</td><td>50</td><td>30</td><td>550</td><td>7775</td><td>0002</td><td>2546</td></tr>
<tr><td>3</td><td>70</td><td>60</td><td>500</td><td>7773</td><td>0004</td><td>5230</td></tr>
<tr><td>4</td><td>90</td><td>90</td><td>450</td><td>7767</td><td>0010</td><td>2546</td></tr>
<tr><td>5</td><td>110</td><td>120</td><td>400</td><td>7757</td><td>0020</td><td>5230</td></tr>
<tr><td>6</td><td>130</td><td>150</td><td>350</td><td>7737</td><td>0040</td><td>2546</td></tr>
<tr><td>7</td><td>150</td><td>180</td><td>300</td><td>7677</td><td>0100</td><td>5230</td></tr>
<tr><td>8</td><td>170</td><td>210</td><td>250</td><td>7577</td><td>0200</td><td>2546</td></tr>
<tr><td>9</td><td>190</td><td>240</td><td>200</td><td>7377</td><td>0400</td><td>5230</td></tr>
<tr><td>10</td><td>210</td><td>270</td><td>150</td><td>6777</td><td>1000</td><td>2546</td></tr>
<tr><td>11</td><td>230</td><td>300</td><td>100</td><td>5777</td><td>2000</td><td>5230</td></tr>
<tr><td>12</td><td>240</td><td>330</td><td>50</td><td>3777</td><td>4000</td><td>2546</td></tr>
</table></td></tr>
<tr><td>DETECT08.SET</td><td>Same as DETECT06.SET, except all heights and height rates as listed:
<table>
<tr><th>Target</th><th>Start Altitude</th><th>Altitude Rate</th></tr>
<tr><td>1</td><td>0k</td><td>17 ft/sec</td></tr>
<tr><td>2</td><td>10k</td><td>"</td></tr>
<tr><td>3</td><td>20k</td><td>"</td></tr>
<tr><td>4</td><td>30k</td><td>"</td></tr>
<tr><td>5</td><td>40k</td><td>"</td></tr>
<tr><td>6</td><td>50k</td><td>"</td></tr>
<tr><td>7</td><td>60k</td><td>"</td></tr>
<tr><td>8</td><td>70k</td><td>"</td></tr>
<tr><td>9</td><td>80k</td><td>"</td></tr>
<tr><td>10</td><td>90k</td><td>"</td></tr>
<tr><td>11</td><td>100k</td><td>"</td></tr>
<tr><td>12</td><td>110k</td><td>"</td></tr>
</table></td></tr>
<tr><td>MC0000.SET</td><td>Sixteen spokes with ten targets per spoke. All Mode C codes = 0000.</td></tr>
<tr><td>INVAL_MC.SET</td><td>Sixteen spokes with ten targets per spoke. Mode C codes are invalid. (i.e. ABCD = 0001, 0051 or 0071).</td></tr>
</table>

The MC0000.SET and INVAL_MC.SET scenarios were injected to test the ARSR-4 detection and reporting of Mode C replies containing only brackets and Mode C reported altitudes that are outside the allowable range of values.

In addition, civil and military emergency replies were injected into the ATCBI-5. Four scenarios tested ARSR-4 beacon emergency processing and reporting. The four scenarios and a description of each are listed in table 4.1.1.2-2.

EMER001.SET was designed to test the ability of the ARSR-4 to process civilian emergency replies (7500, 7600 or 7700 Mode 3/A codes). The remaining three scenarios (EMER002.SET - EMER004.SET) were designed to test military emergency processing. A military transponder sends four replies in succession to denote an emergency. The F1 bracket pulse of each of the three trailing replies is positioned in the Special Position Identification (SPI) position of the preceding reply.

TABLE 4.1.1.2-2 BEACON EMERGENCY PROCESSING SCENARIOS

Scenario	Description
EMER001.SET	4 of each (7500, 7600, 7700) emergency target. Start range = 100 nm. Range movement varies from 700 to 150 nm/hr. Runlengths vary from 40 to 25.
EMER002.SET	3 military emergency targets. First target set contains 4 replies with only brackets in replies 2 - 4. Second target set has 2nd reply missing. Third target set has 3rd reply missing.
EMER003.SET	3 military emergency targets with nominal min and max spacing (up to 300 ns error). Each target set contains 4 replies.
EMER004.SET	3 military emergency targets. Same as EMER002.SET except same code in all four replies for each target set.

To exercise ARTCC status message bits, faults were injected or configuration changes were made to the ARSR-4 while data were recorded with IRES. RMS menus were observed for the appearance of alarms with injected faults. Recorded data were analyzed to ensure that an extra status message was reported at the time of the change and that the correct bit was set in the message. A description of the action taken to exercise each bit is included in the Results section to follow.

The comparison between the CD-2 reported status and the beacon environmental RMS status could not be performed because beacon environmental RMS software was not operating at the time of the test.

Data Analysis

The IRES RECORD program automatically detects reports that are not CD-2 compatible and reports an error on the reception of these reports. These RECORD indications were monitored during recordings.

IRES SCANSUM and COUNTPCS programs were used to verify that the ARSR-4 reported a search RTQC, beacon RTQC, and at least one status message per scan during target of opportunity recordings.

The SHOWPCS program was used to verify that injected beacon replies produced ARSR-4 CD-2 messages with the correct range, azimuth, codes, and emergency bits set.

SHOWPCS and SHOWSTAT programs were used to inspect the recorded status messages to ensure that the expected bits toggled when the ARSR-4 configuration was changed or when a fault was injected into the system.

Results

The ARSR-4 transmits messages that are compatible with the CD-2 format. The ARSR-4 output all message types to the ARTCC user with the exception of a search permanent echo (PE). The clutter returns from the selected PE are filtered by ARSR-4 doppler processing and are not consistently reported to the user. Discussion with Los Angeles ARTCC personnel indicated that the beacon PE is primarily monitored and the absence of a search PE is not an operational problem.

Inspection of 26512 scans of target of opportunity data recorded during the OT&E retest period (from June 5, 1995 to July 20, 1995) showed only two cases where a beacon RTQC was not output on a scan and three cases where a search RTQC was not output on a scan. At least one status message was reported on each scan.

The search RTQC dropouts may have been caused by external interference whose effects may have been exaggerated by the close proximity of the ARSR-3. The causes for the beacon RTQC dropouts are unknown. The low RTQC dropout rate is not an operational problem.

Inspection of IRES data recorded when DETECT06.SET and DETECT08.SET scenarios were injected, showed that detected targets reported the expected range, azimuth, and Mode 3/A, Mode 2, and Mode C codes. Each of the Mode code bit combinations were successfully verified during OT&E retest.

Results showed that when targets with 0000 Mode C codes (brackets only) were injected, the ARSR-4 correctly reported -1000 feet altitude. When targets with invalid Mode C altitudes (D1 bit set and C1, C2, and C4 bits = 000, 101, or 111) were injected, the ARSR-4 correctly reported -99900-foot altitude in the beacon message during OT&E retest.

During the initial phase of OT&E, the ARSR-4 failed to detect a military emergency situation and report a 7700 code in position of the first reply. Instead, four reports were generated for the injected reply trains. The first three replies in each train had the SPI bit set in the report sent to the user. This problem was described in TDR ACW-098 listed in appendix A.

After changes were made to ARSR-4 software to correct the military emergency detection problems, the tests were repeated during OT&E regression. For each beacon emergency scenario injected, the ARSR-4 correctly reported a 7700 code with the emergency bit set in the beacon message.

A second beacon emergency problem was discovered during OT&E. When a 7700 coded Mode 2 reply was input to the ARSR-4 processor, the LDC erroneously reported the reply as an emergency. For this case, the false emergency indication was limited to the LDC and was not sent to the ARTCC. This problem is described in TDR ACW-113, listed in appendix A.

No ARSR-4 change was made to correct the erroneous reporting of a 7700 Mode 2 code as an emergency target on the LDC and therefore no further testing was performed during OT&E regression. Since this problem is localized to the LDC, the controller does not see the false beacon emergency target.

Table 4.1.1.2-3 shows the results of status bit tests. Of the 34 bits in the ARTCC status message, 27 bits were demonstrated to operate properly. Seven bits were not tested. Four of those bits (BCOL, OLBA, SBBEAL, OLRBAL) needed an operational Integral Systems Monitor (ISM) to test. The beacon environmental RMS, which interfaces to the ATCBI ISM, was not functioning at the time of the test. The remaining three bits (M4ALA, BTPRAA, and BTPAZA) were not tested due to the inability to inject a proper fault at Mt. Laguna.

Conclusions

a. The ARSR-4 reports all expected message types in the correct format to the ARTCC except a search permanent echo. Users at the Los Angeles ARTCC do not consider the absence of a search PE as an operational problem.

b. The ARSR-4 reliably output beacon and search RTQCs and status messages to the user during the OT&E retest period.

c. All of the fields in the ARTCC beacon message operate as expected, including the beacon emergency indications.

d. Mode 2 replies with a 7700 code are erroneously shown as an emergency on the LDC Plan Position Indicator (PPI)/Random Access Plan Position Indicator (RAPPI). The beacon messages sent to the ARTCC are not effected.

e. Changes in ARSR-4 status are detected and accurately reported in the status messages sent to the ARTCC. The 27 status bits that were exercised (out of a possible 34 bits), operated properly.

f. Since the beacon environmental RMS was not functioning during the retest period, four of the status bits were not tested and a comparison between the ARSR-4 status and beacon environmental RMS status was not done.

Recommendations

a. When the beacon environmental RMS becomes operational, the status reported by the ARSR-4 and beacon environmental RMS should be compared for consistency.

b. The erroneous emergency indication on the LDC when 7700 coded Mode 2 replies are processed should be fully documented in the Technical Instruction Books.

TABLE 4.1.1.2-3. ARTCC STATUS BIT TEST RESULTS

Bit #	Bit	Description	Test Method	Results
1	TEST	Test Target	Checked test bits in data	Pass
11	FAA	FAA User	Configured User 1 as FAA	Pass
12	AF	Air Force User	Configured User 1 as AF	Pass
14	RDRCHN	Radar Channel	Always set to 1	Pass
15	BCOL	BCN Chan. Online	Needs Operational ISM	Not Tested
16	DPALA	Data Proc.Alarm	Removed Modem cable in RCJB	Pass
17	OLBA	Online BCN Alarm	Needs Operational ISM	Not Tested
18	HNBO	1/2 nm offset	Enabled, then disabled 1/2 nm beacon offset	Pass
19	M4ALA	Mode 4 Alarm		Not Tested
20	POLCHA	Polarization Change	Set sectors 0-3 to CP. Reset those sectors to LP. Set all sectors to CP. Reset to LP.	Pass
21	SBBEAL	Standby BCN Alarm	Needs Operational ISM	Not Tested
22	OLRBAL	Online RBPM Alarm	Needs Operational ISM	Not Tested
25	SYSOH	System Overheat	Adjusted IF cabinet temp thresholds to cause soft, then hard alarms	Pass
29	BRTQCA	Beacon RTQC alarm	Removed cable at J52 in RCJB	Pass
30	SRTQCA	Search RTQC Alarm	Toggled Search RTQC at menu 5.2.8	Pass
31	BTPRAA	BCN clock failure	Needs Hardware Fault Injection	Not Tested
32-35	OUSRAL*	Output Service Alarms	Run 457,468	Pass
36	BTPAZA	BCN Azimuth Alarm	Needs Hardware Fault Injection	Not Tested
37-38	BETAPR	BCN Proc.Status	Placed Beacon B to REPR to verify "Redundancy In Use". Faulted Beacon A by removing mode pair triggers.	Pass
40-41	WXCHST	Weather Channel Status	Ground TP22 on A101 with spare in REPR.	Pass
42	WXSTAL	Weather Station Alarm	Removed J2 cable at top of Data Processor cabinet	Pass
43	MODALA	Modem Alarm	Removed Modem cable in RCJB	Pass
44	TISALA	Time In Storage Alarm	Set Time in Storage to minimum at menu 5.6.2.7. Injected capacity test targets.	Pass
45	BOA	Buffer Overload	Same as TISALA	Pass
46	BOFA	Buffer Overflow	Same as TISALA	Pass
48-51	P0*STA	Port 1-4 Status	Varied User 1 port assignments	Pass

4.1.1.3 Degraded Operations.

Purpose
Ensure that, in the event of a failed modem, the ARSR-4 transmits data over the remaining operating modems and that high priority messages are given preference in transmission.

Test Objectives

a. Verify that the ARSR-4 can detect a modem failure and redirect data transmission over the remaining, operating modem channels.

b. Verify that priority messages (i.e., beacon emergency, status, RTQC) reports are output during overflow and overload conditions.

Test Description
Data was recorded using IRES setup on user 1 ports (AF1 and AF2). The ports were configured for ARTCC operation and each operated at 4800 baud. Emergency beacon test targets (codes 7700, 7600, and 7500) were injected at RF into the ATCBI-5. Twelve targets (four of each emergency code) were injected per scan. The 25MAY95 software build was installed in the ARSR-4 for the test.

Two tests (RUN 527 and RUN 528) were performed to verify that the ARSR-4 can detect an unterminated serial port and route the data to an operational channel. RUN 527 contained 65 scans of data. On scan 25 of the recording, the AF1 cable was disconnected from the J28 jack in the RCJB, leaving only the AF2 cable connected for user 1. The AF1 cable was not reconnected to J28 during the remainder of the recording.

On scan 45, the Time In Storage (TIS) parameter on RMS menu 5.6.2.7 was adjusted to .5 seconds in an attempt to induce TIS alarms in the formatter. By design, the ARSR-4 should not output data that exceeds this TIS limit. The data was inspected to verify that priority reports were not eliminated due to the TIS filtering.

RUN 528 contained 90 scans of data. The TIS was reduced to .25 seconds prior to the start of recording. The cable at J28 (AF1) was disconnected at scan 25 of the recording. The cable was reconnected to J28 on scan 60.

Data Analysis
During each test, the ARSR-4 RMS alarm menus were monitored to ensure that the TIS and modem faults were detected and reported by Built-In Test (BIT). Alarm data were also recorded on a computer connected to the ARSR-4 MPS port. The Maintenance Processor System (MPS) text files were also analyzed to ensure that the ARSR-4 reported the expected modem and TIS alarms.

The surveillance data was analyzed using IRES. PLOTSCAN plotted the report counts per scan and produced tables containing the data counts. The FILTER program removed search and non-emergency beacon reports from the file. The COUNTPCS program counted the number of

beacon emergency reports, beacon RTQC, and status messages recorded. SHOWPCS was used to ensure that the modem and TIS alarms were accurately reported in the ARTCC status message.

Results

Figure 4.1.1.3-1 is a PLOTSCAN plot for RUN 527. There are two graphs in the figure. Each graph plots report counts versus scans. The upper graph displays the radar only (RO) (upper, jagged trace), radar beacon merge (RB) (middle trace), and beacon only (BO) (lower trace) counts per scan. The lower graph displays search RTQC, beacon RTQC, status message, and strobe counts per scan.

The upper graph of figure 4.1.1.3-1 shows that the beacon report counts per scan remain fairly constant throughout the data recording. The radar only trace is likely fluctuating due to external interference and interference from the collocated ARSR-3.

In the lower graph of figure 4.1.1.3-1, the two largest spikes in the data counts are due to extra status messages on the scan when the cable was disconnected and on the scan when the RMS TIS parameter was changed. Note that there was no significant loss of data when the cable was disconnected in scan 25. This indicates that the ARSR-4 detected the unterminated port and routed data over the operating port.

Review of the ARTCC status message and MPS data showed that the faulted port was in alarm while the cable was disconnected. However, a TIS alarm condition was reported for only several scans of the recording, indicating that the RMS TIS parameter was not low enough for the test.

The RUN 527 data was filtered to remove RO and nonemergency beacon targets. Figure 4.1.1-3-2 shows the PLOTSCAN display of beacon emergency data counts in the upper graph and status, and beacon and search RTQC counts in the lower graph. Table 4.1.1.3-1 presents the data in tabular form.

In the upper graph of figure 4.1.1.3-2, the BO emergency reports are shown in the upper trace and the merged emergency reports are shown as small, individual spikes in the lower trace.

Inspection of the data using the SHOWPCS program revealed that the ARSR-4 did not output 1 of the 12 injected beacon emergency reports on scans 11, 45, and 46. On scans 11 and 46, the emergency test target was reported with a zero Mode 3/A code due to garbling from a nearby real aircraft. The emergency report was missing on scan 45 due to the disconnection of the modem cable.

The lower graph of figure 4.1.1.3-2 shows that extra status messages were output to the ARTCC on the scans where the AF1 cable was disconnected and where the TIS parameter was adjusted. Note the RTQCs were reported for each scan except the scan when the cable was disconnected.

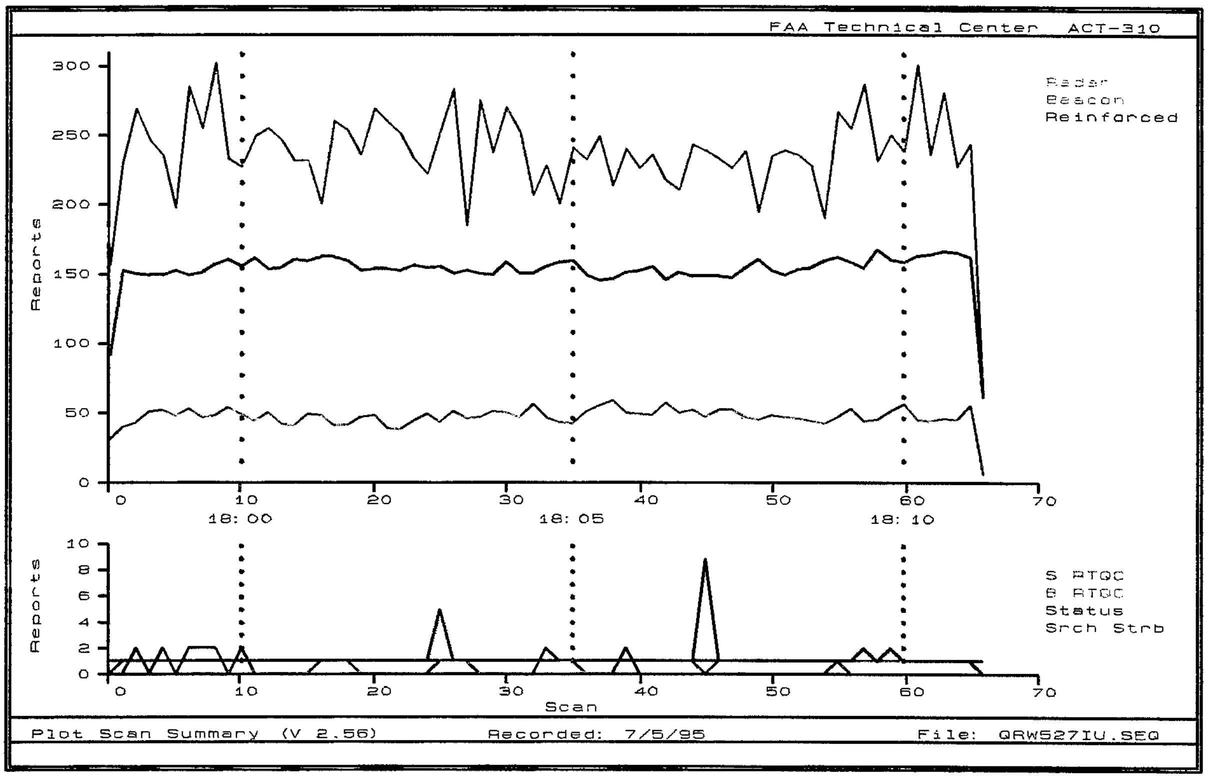

FIGURE 4.1.1.3-1 RUN527 - REPORT COUNTS PER SCAN

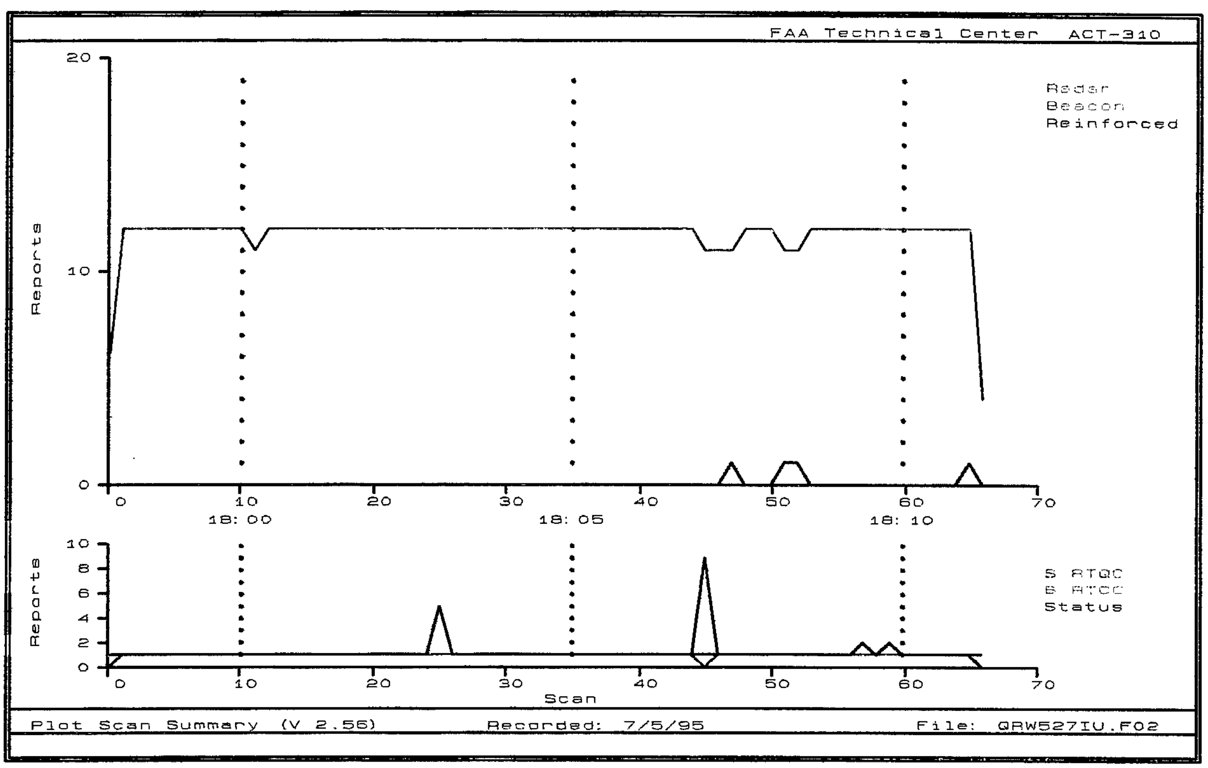

FIGURE 4.1.1.3-2 RUN527 - EMERGENCY BEACON REPORTS

TABLE 4.1.1.3-1. RUN527 - EMERGENCY BEACON REPORTS

Scan	BO	RB	Srch RTQC	Bcn RTQC	Stat.	Scan	BO	RB	Srch RTQC	Bcn RTQC	Stat.
1	12	0	1	1	1	34	12	0	1	1	1
2	12	0	1	1	1	35	12	0	1	1	1
3	12	0	1	1	1	36	12	0	1	1	1
4	12	0	1	1	1	37	12	0	1	1	1
5	12	0	1	1	1	38	12	0	1	1	1
6	12	0	1	1	1	39	12	0	1	1	1
7	12	0	1	1	1	40	12	0	1	1	1
8	12	0	1	1	1	41	12	0	1	1	1
9	12	0	1	1	1	42	12	0	1	1	1
10	12	0	1	1	1	43	12	0	1	1	1
11	11	0	1	1	1	44	12	0	1	1	1
12	12	0	1	1	1	45	11	0	1	0	9
13	12	0	1	1	1	46	11	0	1	1	1
14	12	0	1	1	1	47	11	1	1	1	1
15	12	0	1	1	1	48	12	0	1	1	1
16	12	0	1	1	1	49	12	0	1	1	1
17	12	0	1	1	1	50	12	0	1	1	1
18	12	0	1	1	1	51	12	0	1	1	1
19	12	0	1	1	1	52	11	1	1	1	1
20	12	0	1	1	1	53	12	0	1	1	1
21	12	0	1	1	1	54	12	0	1	1	1
22	12	0	1	1	1	55	12	0	1	1	1
23	12	0	1	1	1	56	12	0	1	1	1
24	12	0	1	1	1	57	12	0	1	1	2
25	12	0	1	1	5	58	12	0	1	1	1
26	12	0	1	1	1	59	12	0	1	1	2
27	12	0	1	1	1	60	12	0	1	1	1
28	12	0	1	1	1	61	12	0	1	1	1
29	12	0	1	1	1	62	12	0	1	1	1
30	12	0	1	1	1	63	12	0	1	1	1
31	12	0	1	1	1	64	12	0	1	1	1
32	12	0	1	1	1	65	12	0	1	1	1
33	12	0	1	1	1						

Figure 4.1.1.3-3 contains a PLOTSCAN plot for RUN 528. The figure has a similar appearance to figure 4.1.1.3-1 except that there were more status messages reported as the system transitioned in and out of TIS alarm. As was the case for RUN527, the reinforced and beacon reports per scan remain fairly constant. Review of the status message and MPS data showed that the modem alarm (MODALA and P01STA) were reported at the expected times.

Figure 4.1.1.3-4 shows the PLOTSCAN display of beacon emergency data counts in the upper graph and status, and beacon and search RTQC counts in the lower graph. Table 4.1.1.3-2 presents the data in tabular form.

On scans 9, 21, and 22, one of the twelve injected emergency targets was not reported to the user. In each of those cases, the emergency test target was reported with a zero Mode 3/A code due to garbling from a nearby real aircraft.

The lower graph in figure 4.1.1.3-4 shows that extra status messages were output to the ARTCC on the scans where the AF1 cable was disconnected (scan 25) and reconnected (scan 60). Search and beacon RTQCs were reported on each scan.

Inspection of the status message contents using SHOWPCS revealed that TIS alarms were reported for most of the time between scan 28 and scan 61 of the recording. In that time, the ARSR-4 reported all expected beacon emergency targets, RTQCs, and at least one status message per scan.

Conclusions

a. The ARSR-4 successfully detects a failed modem port and routes data over the remaining operational channels.

b. Priority messages (beacon emergency, RTQCs, and status) are not eliminated during buffer overload and buffer overflow conditions.

4.1.1.4 Modem/Modem Interface.

Purpose

Ensure that the local modems communicate properly with the remote modems.

Test Objective

Verify that the modems provide for the transmission of ARSR-4 digital messages to the end user with a low transmission error rate.

Test Description

The modem interface between the ARSR-4 at Mt. Laguna and the Los Angeles ARTCC was tested to ensure that the modems were properly strapped and that data transmission across the modem lines was satisfactory.

Codex 3600 modems were used to transmit ARSR-4 data to the Center. The configuration and strapping of both modems were optimized to obtain the best data throughput and quick diagnostic responses.

Codex modem straps are contained in table 4.1.1.4-1. Straps which are not listed remained at the manufacturer's default settings. The ARTCC Codex modem was configured as the Remote, while the Mt. Laguna modem was configured as Local. Modem strapping information was obtained from the Codex 3600 Series Users Manual, Part #09299 Rev B.

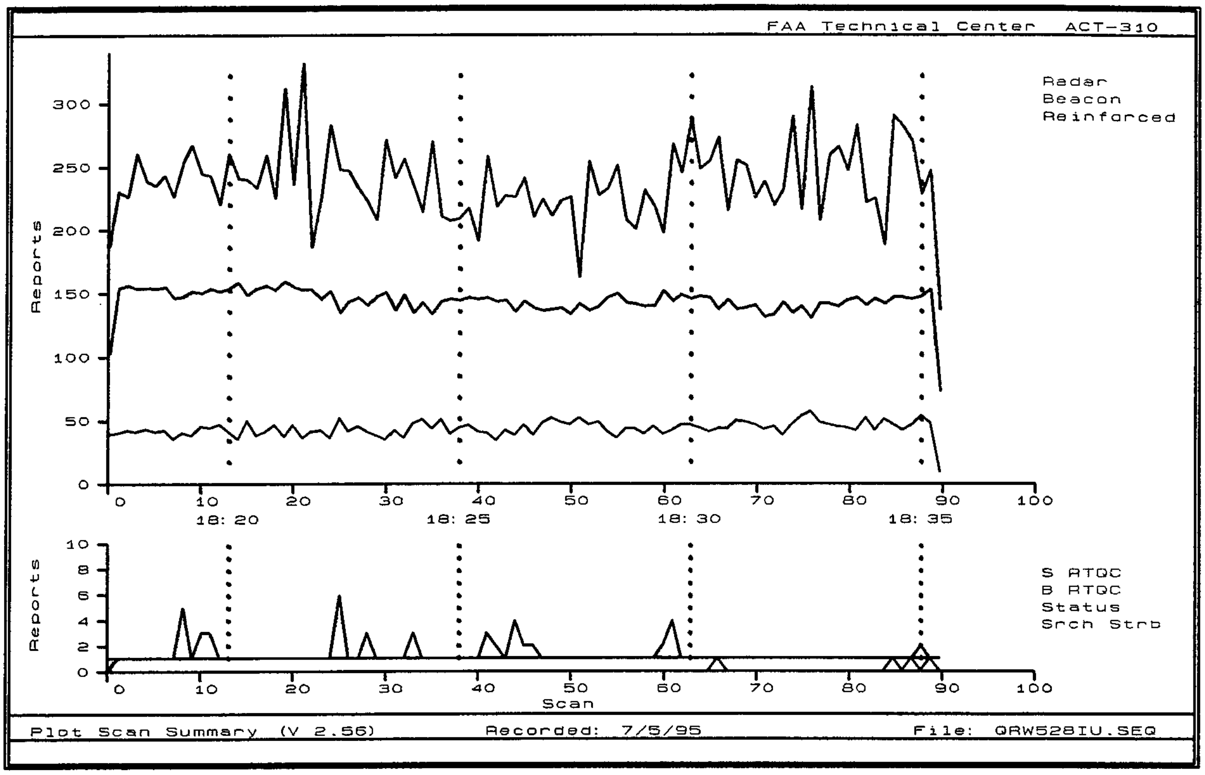

FIGURE 4.1.1.3-3 RUN 528 - REPORT COUNTS PER SCAN

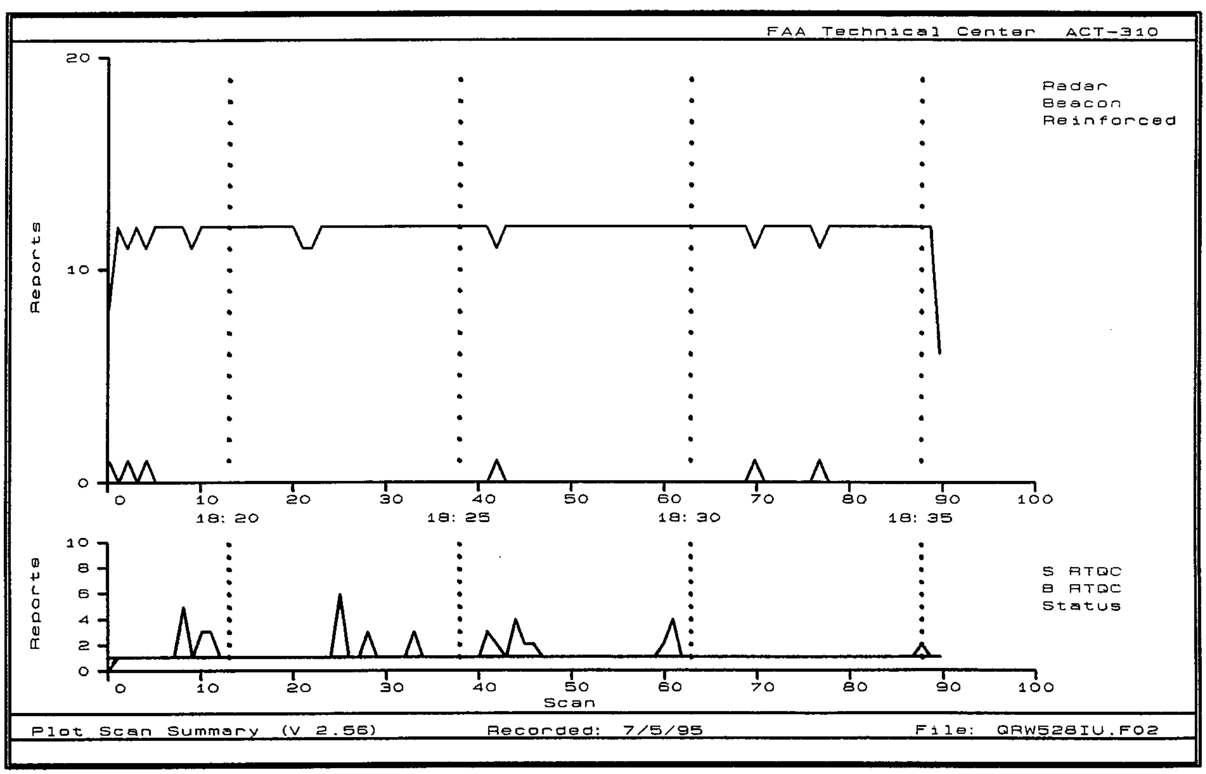

FIGURE 4.1.1.3-4 RUN 528 - EMERGENCY BEACON REPORTS

TABLE 4.1.1.3-2. RUN528 - EMERGENCY BEACON REPORTS

Scan	BO	RB	Srch RTQC	Bcn RTQC	Stat.	Scan	BO	RB	Srch RTQC	Bcn RTQC	Stat.
1	12	0	1	1	1	46	12	0	1	1	2
2	11	1	1	1	1	47	12	0	1	1	1
3	12	0	1	1	1	48	12	0	1	1	1
4	11	1	1	1	1	49	12	0	1	1	1
5	12	0	1	1	1	50	12	0	1	1	1
6	12	0	1	1	1	51	12	0	1	1	1
7	12	0	1	1	1	52	12	0	1	1	1
8	12	0	1	1	5	53	12	0	1	1	1
9	11	0	1	1	1	54	12	0	1	1	1
10	12	0	1	1	3	55	12	0	1	1	1
11	12	0	1	1	3	56	12	0	1	1	1
12	12	0	1	1	1	57	12	0	1	1	1
13	12	0	1	1	1	58	12	0	1	1	1
14	12	0	1	1	1	59	12	0	1	1	1
15	12	0	1	1	1	60	12	0	1	1	2
16	12	0	1	1	1	61	12	0	1	1	4
17	12	0	1	1	1	62	12	0	1	1	1
18	12	0	1	1	1	63	12	0	1	1	1
19	12	0	1	1	1	64	12	0	1	1	1
20	12	0	1	1	1	65	12	0	1	1	1
21	11	0	1	1	1	66	12	0	1	1	1
22	11	0	1	1	1	67	12	0	1	1	1
23	12	0	1	1	1	68	12	0	1	1	1
24	12	0	1	1	1	69	12	0	1	1	1
25	12	0	1	1	6	70	11	1	1	1	1
26	12	0	1	1	1	71	12	0	1	1	1
27	12	0	1	1	1	72	12	0	1	1	1
28	12	0	1	1	3	73	12	0	1	1	1
29	12	0	1	1	1	74	12	0	1	1	1
30	12	0	1	1	1	75	12	0	1	1	1
31	12	0	1	1	1	76	12	0	1	1	1
32	12	0	1	1	1	77	11	1	1	1	1
33	12	0	1	1	3	78	12	0	1	1	1
34	12	0	1	1	1	79	12	0	1	1	1
35	12	0	1	1	1	80	12	0	1	1	1
36	12	0	1	1	1	81	12	0	1	1	1
37	12	0	1	1	1	82	12	0	1	1	1
38	12	0	1	1	1	83	12	0	1	1	1
39	12	0	1	1	1	84	12	0	1	1	1
40	12	0	1	1	1	85	12	0	1	1	1
41	12	0	1	1	3	86	12	0	1	1	1
42	11	1	1	1	2	87	12	0	1	1	1
43	12	0	1	1	1	88	12	0	1	1	2
44	12	0	1	1	4	89	12	0	1	1	1
45	12	0	1	1	2	90	6	0	1	1	1

TABLE 4.1.1.4-1. CODEX 3600 MODEM PARAMETERS

Description	Value - Local (Remote)
Current TX Data Rate	19.2 K (19.2 K)
Current Rx Data Rate	19.2 K (19.2 K)
Port 1 Rate	2.4 K (2.4 K)
Port 2 Rate	2.4 K (2.4 K)
Port 3 Rate	2.4 K (2.4 K)
Port 4 Rate	2.4 K (2.4 K)
Port 5 Rate	2.4 K (2.4 K)
Port 6 Rate	2.4 K (2.4 K)
Port 7 Rate	2.4 K (2.4 K)
Port 8 Rate	2.4 K (2.4 K)
OP MODE	Turbo PP
Rate-O	19.2 KBPS (19.2 KBPS)
TX-LVL	-13 dBm (-13 dBm)
CDTHR	-26/-31 (-26/-31)

Internal modem diagnostics tests were performed to verify modem operation, line quality, and data integrity. During BIT Error Rate and Block Error Rate (BER) tests, the transmit and receive modems looped data through the other modem to the originating modem where the data was compared. The error rates were then displayed on the modem front panel. The accumulated error rates were recorded for the 15-minute test.

In addition to the internal modem diagnostics, data was recorded at the output of the ARSR-4 (using an IRES recorder) and at the output of the ARTCC modem (using an MX6 recorder). The two users were identically configured with each containing three ports of 2400 baud. The data was then compared.

Data Analysis

The MX6 recorded data was converted to IRES format using the COPYCD program. The two data sets were then compared using the IRES COMPARE program. In addition, the COUNTPCS program verified that the ARSR-4 output the expected Search RTQC, Beacon RTQC, and Status message counts on each scan.

Results

At the start of Codex tests, the modem power was cycled which initiated the internal modem self test. The internal self test automatically verified proper modem operation by displaying the transmit data rate on the front panel.

Table 4.1.1.4-2 shows the Codex modem performance parameters as measured by the Circuit Quality Monitoring System (CQMS) of the modem. All values are within tolerance.

TABLE 4.1.1.4-2. CODEX MODEM LINE CHARACTERISTICS

Description	Value Local,(Remote)
Phase Jitter (PJ)	0 Deg., (0 Deg.)
Received Level (RL)	-13 dB, (-15 dB)
Error Rate Percent (ERP)	0 %, (0 %)
Phase Hits (PH)	0 Hits, (0 Hits)
Drop Outs (DO)	0, (0)
SNR	033, (036)
RTN	1, (2)
BP	0, (0)

The BER test was performed for a 15-minute period with a normal configuration of three ports operating at 2400 baud. Zero block errors and zero bit errors were detected on ports 1, 2, and 3. A second 5-minute BER test was conducted with a single channel/port configured at 9600 baud. Zero errors were reported on the single port.

Data counts for the Mt. Laguna and Los Angeles recorded data are shown in table 4.1.1.4-3. The results show identical target counts for each scan except scan 43. In scan 43, the Mt. Laguna data (denoted by and asterisk in the table) contained one more search report than the Palmdale data.

The single search report was most likely lost due to an error in transmission. Of the 14229 reports output from the ARSR-4 during the test, the single dropped report corresponds to an error rate of approximately 7 x 10^{-5}. This low error rate is operationally acceptable.

Conclusions

a. The modem settings, line characteristics, and line quality are acceptable.

b. The error rate checks and other diagnostic tests performed internally by each modem indicate that the modems can adequately configure, monitor, and test their individual communication lines.

c. The Mt. Laguna ARSR-4 transmits data to the ARTCC with an acceptably low error rate.

4.1.2 Surveillance via Mode S to ARTCC.

Purpose

The purpose of this test was to verify that the ARSR-4, when interfaced to a Mode S, provides the proper data in a timely manner to the ARTCC.

Test Objectives

a. Verify that the ARSR-4/Mode S Interface Control Document (ICD) provides information consistent with an effective interface with the Mode S.

b. Verify that the ARSR-4 transmits correct status information to the Mode S.

TABLE 4.1.1.4-3. DATA COUNTS FOR MT. LAGUNA AND LOS ANGELES

Scan	Radar Only	Beacon Only	Radar Beacon	Search RTQC	Beacon RTQC	Strobe	Status	Total
1	123	54	151	1	1	0	60	390
2	105	58	143	1	1	0	13	321
3	102	63	145	1	1	0	1	313
4	114	71	140	1	1	0	1	328
5	106	72	143	1	1	0	1	324
6	106	76	135	1	1	0	1	320
7	91	79	132	1	1	0	1	305
8	86	74	140	1	1	0	1	303
9	90	84	133	1	1	0	1	310
10	86	75	138	1	1	0	1	302
11	106	76	136	1	1	0	1	321
12	110	71	134	1	1	1	1	319
13	122	71	140	1	1	1	1	337
14	88	76	130	1	1	0	1	297
15	94	72	135	1	1	0	1	304
16	119	77	136	1	1	1	1	336
17	107	81	128	1	1	2	1	321
18	110	82	137	1	1	2	1	334
19	106	82	129	1	1	0	1	320
20	95	81	133	1	1	0	1	312
21	109	82	133	1	1	2	1	329
22	123	74	139	1	1	2	1	341
23	115	75	143	1	1	2	1	338
24	131	75	141	1	1	2	1	352
25	101	79	143	1	1	2	1	328
26	130	76	146	1	1	2	1	357
27	93	75	148	1	1	2	1	321
28	111	67	149	1	1	2	1	332
29	124	79	142	1	1	2	1	350
30	128	75	137	1	1	2	1	345
31	106	77	136	1	1	2	1	324
32	113	69	140	1	1	0	1	325
33	109	69	140	1	1	0	1	321
34	106	71	144	1	1	2	1	326
35	114	72	143	1	1	2	1	334
36	107	68	139	1	1	2	1	319
37	106	57	144	1	1	2	1	312
38	115	66	147	1	1	2	1	333
39	125	74	146	1	1	2	1	350
40	104	62	150	1	1	0	1	319
41	102	61	125	1	1	1	4	295
42	92	56	152	1	1	0	1	303
43	105	64	139	1	1	0	4	314
			*140					*315
44	93	70	142	1	1	0	1	308
45	108	68	146	1	1	0	1	325

Test Description

Due to the unavailability of the Mode S for testing at Mt. Laguna, the Mode S OT&E integration tests were limited to review of the ARSR-4/Mode S interface control document and simulated tests using a protocol analyzer to emulate the Mode S.

For the simulated tests, a Telenex Turbo 8600 protocol analyzer was configured to emulate Data Communications Equipment (DCE). The Mode S RS-530 port in the ARSR-4 was configured to communicate at 9600 baud. The test consisted of verifying that status bits accurately reflected the status of the ARSR-4.

Data Analysis

The review of the ARSR-4/Mode S interface control document was performed by the Mode S OT&E group at the FAA William J. Hughes Technical Center (ACT-310). The Mode S OT&E test group has been extensively involved in Airport Surveillance Radar Model 9 (ASR-9)/Mode S interface testing. The document was reviewed for the technical content concerning ARSR-4 and Mode S channel switching and switching to Interm Beacon Interrogator (IBI) mode in the Mode S.

ARSR-4 data collected with the protocol analyzer was converted to IRES format, then inspected for proper message content using IRES SHOWPCS and SHOWSTAT programs.

Results

Interface Control Document Review

Review of the ARSR-4/Mode S ICD produced several critical concerns.

In section 3.2.1.1.c of the ICD, the statement "Both Mode S processors reporting DCE Ready lines ON or OFF for more than 150 millisecond (ms) constitute a failure of both Mode S processors, and therefore, causes the ARSR-4 to go to backup mode." would present a problem if implemented. In-channel recoveries commonly take up to 1 second to complete, during which time DCE READY may be dropped. Assuming DCE READY is dropped for longer than 150 ms, the ARSR-4 would configure into backup mode, dropping Data Terminal Equipment (DTE) READY, causing the Mode S to first switch channels and then drop into Air Traffic Control Beacon Interrogator (ATCBI) mode. This would be a gravely undesirable result after a simple Mode S software trap had caused an in-channel recovery. Suggest designing the ARSR-4 interface to allow for up to a 1-second loss of DCE READY to avoid unnecessary reconfiguration of the two systems. This is the current implementation in the ASR-9 software.

In section 3.2.6.1.2.1, Online Status Loop Test, the ARSR-4 looping a status message "at a minimum" of once per scan sounds insufficient. The ASR-9 currently issues a "health check" message every other sector. Moreover, waiting 4 seconds before incrementing the failure counter sounds like too long a time duration. If the failure counter (defined at the beginning of the section) is set to 3, for instance, then data can be lost for up to 12 seconds before a hard fault is declared.

Section 3.2.6.1.3, Mode S Active Channel Reconfiguration, is incomplete. This section discusses how the ARSR-4 tracks channels of the Mode S, but fails to discuss how the ARSR-4 must cause Mode S channel switches to fully utilize all interface paths. For example, if a hard interface fault occurs (the necessary number of status loopback messages are consecutively missing), the ARSR-4 first switches Serial I/O boards. Should the status messages still be missing, the ARSR-4 must force a Mode S reconfiguration (channel switch) by dropping the uplink discrete on the on-line RS-530 channel. The Mode S will switch channels, causing DCE READY in the newly on-line channel to go high. The ARSR-4 must sense this, switch RS-530 channels on the spare (now on-line) Serial I/O board, and must now provide the uplink discrete (DTE READY) to give this Mode S channel a chance. Should the loopback status messages still be missing, the ARSR-4 can either switch back to the original Serial I/O board, or drop the uplink discrete again to force reconfiguration into backup mode at the Mode S.

Regarding section 3.2.6.1.6, functionality does not exist in the fielded full-up Mode S system to support transition into and out of Mode 4 operation.

In section 3.3.2.2.4, it is unclear at this time how much of the required analog interface functionality currently exists in the Mode S interrogator. With the Mode S operating in backup mode, some changes in interrogator software are likely to be required for the Mode S to acknowledge the Mode 4 enable, begin modulating RF with the Mode 4 pulses, and to send the appropriate quantized video and mode triggers back to the ARSR-4.

Protocol Analyzer Tests

Table 4.1.2-1 shows the results of tests on some of the ARSR-4 status message bits sent to Mode S. The test method used to produce the status change is also included in the table.

Conclusions

a. The ARSR-4, as described in the ARSR-4 to Mode S ICD, will not interface with the Mode S in its present configuration.

b. Insufficient time (150 ms) is allowed by the ARSR-4 for loss of DCE Ready on the interface. DCE Ready can be dropped during Mode S in channel recoveries (which can take up to 1 second). The loss of DCE Ready for more than 150 ms can trigger a series of unnecessary reconfigurations in both the ARSR-4 and the Mode S.

c. The use of ARSR-4 and Mode S status message loopback is most likely inadequate for fault detection in the data link layer of the interface due to the infrequent occurrence (once per scan) of the status message.

d. The Mode S, as presently configured, does not support transition into and out of Mode 4 operation.

e. The results of the simulated protocol analyzer tests revealed that ARSR-4 status is not correctly reported to Mode S for some of the status bits.

TABLE 4.1.2-1. ARSR-4 / MODE S STATUS MESSAGE TESTS

Status Bit	Description	Test Method	Results
ANDRAL	Antenna Drive Alarm	Alternately turned off drive motors	Fail
ANTALA	Antenna Alarm	Induced alarm through threshold adjustment.	Fail
APGONL	APG Online	Changed online APG	Pass
AZALA	Azimuth Alarm	Induced APG alarms through threshold adjustment	Pass
BETAPR	Beacon Target Processor Status	Changed online Processor	Pass
DEFKA	Default Ka	Disconnected J2 and J12 on Data Processor	Pass
DPALA	Data Processor Alarm	Unterminated port	Pass
DPRIST	Data Processor Radar Interface Status	Put Radar Interface Board into REPR	Pass
DPTOYS	Data Processor TOY status	Cycled power to TOY clock	Fail
FRSOST	Frequency Source Status	Frequency Generator B to REPR, back to STBY	Pass
HNBO	1/2 nm beacon offset	Enabled/disabled half mile beacon offset	Pass
MPSCOM	MPS Communications	Unterminated port	Fail
POLCHA	Polarization Change	Change from LP to CP	Pass
RDRALA	Radar Alarm	Induced IF RCVR Power Supply alarm through threshold adjustment.	Fail
RDSYST	Radar System Status	Induced alarms through threshold adjustment	Fail
SPALA	Signal Processor Alarm	Induced alarm through threshold adjustment	Pass
SPSTAT	Signal Processor Status	Put Sync B in REPR then STBY	Fail
SUM4ON	Supermode/Mode 4 only	Toggled between Supermode and Mode 4 Only.	Pass
SYSCON	System Control	Transferred system control from LDC to MDT	Pass
TRAN00	Transmitter On/Off	Toggled RF on/off	Fail
TXSTAT	Transmitter Status	Put Preamp 2 into REPR; Induced alarms through threshold adjustment	Pass
VLDRST	Vault Door Status	Alternately opened/closed vault doors	Fail
WXSTAL	Weather Station Online Alarm	Disconnected J2 and J12 on Data Processor	Pass

Recommendations

a. The ARSR-4/Mode S ICD and ARSR-4 system design should be corrected to enable interface with the Mode S.

b. Incorrect ARSR-4 status reporting should be corrected.

c. A full integration test is recommended for the first site which has an ARSR-4 and a Mode S. The test should include data throughput, format verification, capacity and delay, channel switching, and Mode S/Mode 4 compatibility tests.

4.1.3 Weather Surveillance to RRWDS.

Purpose

The purpose of this test was to verify that the ARSR-4, when interfaced with the Radar Remote Weather Display System (RRWDS), provides accurate weather information to the NWS user.

Test Objectives

a. Verify that the ARSR-4 analog log video output is in a form that will permit the RRWDS digitizer to accurately threshold to the five weather data levels corresponding to the standard NWS values.

b. Verify that the ARSR-4 provides video, pretrigger, and Azimuth Reference Pulse (ARP) and ACP data to the RRWDS at the correct voltages.

c. Verify that the ARSR-4, when interfaced with an RRWDS, provides weather data to the end user that is operationally suitable and effective.

Test Description

The ARSR-4 weather test target generator was used to inject weather test targets (at RF) through the ARSR-4 weather processing path and out to the RRWDS.

The RRWDS weather log video levels were measured using an oscilloscope at J95 of the ARSR-4 RCJB without any attenuation in the path. Weather test targets at 35 decibel (dB), 43 dB, 48 dB, 54 dB, and 60 dB were injected to verify video and position characteristics.

Data Analysis

After the video, pretrigger, ARP, and ACP pulse characteristics measurements were made, RRWDS alignment was attempted using the existing alignment procedures. The ability of the ARSR-4 to supply weather data at the proper NWS level, range, and azimuthal position to the RRWDS was measured.

Results

Pulse characteristic measurements for the ARSR-4 generated video, pretrigger, ARP and ACP signals indicated that the ARSR-4 met specified requirements. However, the RRWDS could not be aligned with the ARSR-4 for the following reasons:

a. For all weather test target levels input, the RRWDS displayed level six weather. The ARSR-4 log amplitude video levels saturated the RRWDS digitizer and the RRWDS could not be aligned to the ARSR-4 output video levels. However, these high video voltages met the ARSR-4 specified requirements.

ARSR-3 weather video voltages were measured in addition to the ARSR-4 voltages. A comparison between the ARSR-3 generated (using the ARSR-3 weather test target generator) weather video voltages and the ARSR-4 generated weather video voltages is shown in figure 4.1.3-1. From the figure, it is seen that at Mt. Laguna, the weather video levels out of the ARSR-4 were approximately 8 dB higher than the ARSR-3 video levels.

The figure shows that even the lowest injected weather level from the ARSR-4 produced a greater log video amplitude than the highest injected weather level from the ARSR-3. Therefore, all ARSR-4 video levels were being interpreted by RRWDS as NWS level 6.

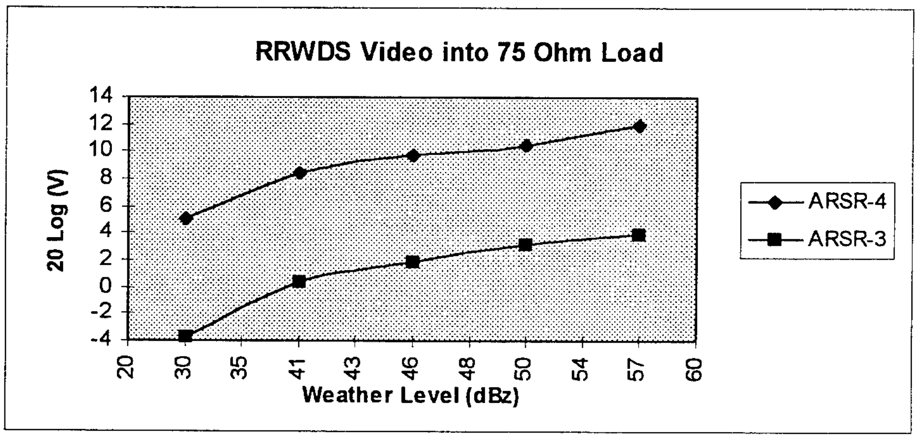

FIGURE 4.1.3-1. ARSR-4 AND ARSR-3 RRWDS VIDEO COMPARISON

b. After a prototype 8-dB attenuator was inserted into the ARSR-4 RRWDS video path, the RRWDS alignment was again attempted with the ARSR-4. Although the ARSR-4 video voltages were now closer to ARSR-3 levels, problems in the RRWDS alignment procedure were encountered. The procedure calls for injection of weather test targets at 145 nm, however, the ARSR-4 injected weather test targets are calibrated at 100 nm.

c. There were also problems aligning the weather video in azimuth on the RRWDS display. There was an approximate 30 to 40° shift in the displayed weather on the RRWDS from the azimuth of the injected target. Further investigation revealed that the ARSR-4 RRWDS ARP is coincident with an ACP. An ARSR-4 contract modification will address a solution.

d. Inspection of the ARSR-4 generated RRWDS weather video on an oscilloscope revealed that BIT video, beyond the maximum range of the radar and RRWDS, is present in the RRWDS video. This BIT information must be gated out of the video through RRWDS alignment.

e. The RRWDS indicated buffer overflow alarms (Errors 46 and 47) when interfaced with the ARSR-4. It is suspected that these alarms are caused by the extended range of the ARSR-4 over the ARSR-3.

Due to the inability of the ARSR-4 to interface effectively with the RRWDS, and the decommissioning of the RRWDS at the ARTCC, the user participation section of the test was not completed.

Conclusions

a. The ARSR-4, in its present form, does not integrate effectively with the RRWDS. The weather video voltage levels are too high for the RRWDS to handle.

b. The existing ARSR-3/RRWDS alignment procedures do not apply to RRWDS alignment with the ARSR-4.

c. The RRWDS, when interfaced with the ARSR-4, does not display weather at the correct azimuth due to the coincidence of the ARSR-4 generated ARP with an ACP. A contract modification has been issued to address the solution to this problem.

d. Additional BIT information is present in dead time in the ARSR-4 video sent to the RRWDS. If not gated out during RRWDS alignment, this BIT video will be displayed as false weather on the RRWDS display.

e. The impact (if any) of RRWDS buffer overflow alarms (Errors 46 and 47) on operation is unknown. The errors may be present due to the extended operating range of the ARSR-4 (as compared to the 200-nm ARSR-3).

f. The operational suitability and effectiveness were not evaluated by the end users due to the inability to establish the interface and the lack of a commissioned RRWDS at the ARTCC.

Recommendations

a. Available Commercial-Off-The-Shelf (COTS) attenuators can be used to reduce present ARSR-4 weather video levels to usable levels for the RRWDS. AOS-230 is pursuing this solution.

b. RRWDS alignment procedures should be updated to reflect the differences in calibration ranges between the ARSR-3 and the ARSR-4 and the gating of BIT video out of the ARSR-4 generated video.

c. After the azimuth problems are corrected via the contract modification, the RRWDS integration with the ARSR-4 should be retested with participation from the end users. At that time any operational effects of RRWDS buffer overflow errors can be assessed.

4.1.4 Surveillance to SOCC/FACSFACS.

Purpose
This test was designed to verify that the ARSR-4 functionally and physically interfaces with the SOCC and FACSFAC in accordance with USAF and Navy operational requirements.

ACT-310 performed tests to evaluate SOCC status message bit operation. The results of these tests are included in this section. The results for the remaining SOCC and FACSFAC tests, performed by the USAF and the Navy, are not presented in this report.

Test Objective
Verify that the status transmitted in the military formatted messages accurately reflect the status of the ARSR-4.

Test Description
Faults were induced and reconfigurations made to the system to exercise each bit in the status message. Data were collected from user ports AF1 and AF2 (configured to output USAF status messages) using the IRES recorder.

Data Analysis
The data were analyzed using IRES. The SOCC status message was examined with the SHOWPCS and SHOWSTAT programs to verify that the information provided reflects the true status and the proper configuration of the ARSR-4.

Results
The four-word SOCC status message contains 24 bits to indicate ARSR-4 status. Twenty-two bits were exercised during the test. Table 4.1.4-1 contains the test method used and the result for each bit.

Of the 22 SOCC status bits tested, 19 functioned as expected. The ARSR-4 failed to generate expected status for three of the bits when the system configuration was changed or when faults were introduced into major subsystems. Two bits (M4PRST, KGSTAT) could not be verified due to the configuration at the Mt. Laguna site, test setup, or Government Furnished Equipment (GFE) not present at the site.

Conclusions
Nineteen of the 22 status bits tested operated as expected. The SPSTAT, M4INOR, M4ALA failed to operate as expected.

Recommendations
The USAF and United States Navy should evaluate the operational significance of these results.

TABLE 4.1.4-1. SOCC STATUS MESSAGE TEST RESULTS

Bit	Test Method	Result
HNBO	Enabled, then disabled 1/2 nm offset.	Pass
POLCHA	Toggled between LP and CP	Pass
SUM4ON	Toggled between supermode and Mode 4 only operation.	Pass
MODALA	Disconnected, then reconnected modem cable in RCJB.	Pass
SRTQCA	Disabled the search RTQC on menu 5.2.8. Ten scans later, enabled the RTQC. The SRTQCA bit was set approx. seven scans after the RTQC was disabled. The bit was reset approx. six scans after the RTQC was reenabled.	Pass
BETAPR	Placed all reconfigurable elements of beacon channel B to REPAIR. Removed mode pair trigger input to the RCJB to induce BRTQC alarm.	Pass
BRTQCA	Placed all reconfigurable elements of beacon channel B to REPAIR. Removed mode pair trigger input to the RCJB to induce BRTQC alarm.	Pass
BOFA	Recorded data on ports AF1 and AF2 at 4800 baud. Set the Time in Storage (TIS) to minimum. Disconnected, then reconnected cable at J28 (AF1)	Pass
USRALA	Recorded data from ports AF1 and AF2 at 4800 baud. Set the Time in Storage (TIS) to minimum. Disconnected, then reconnected cable at J28 (AF1)	Pass
VLDRST	Opened, then closed, Mode 4 safe doors.	Pass
M4CONT	Toggled Mode 4 control between SOCC and LDC via LDC/SOCC switch in safe A.	Pass
KRSTAT	Toggled power for the KIR in safe A.	Pass
M4PRST	Not Tested	
FRSOST	Placed Sync. B into REPR. Placed Frequency Generator Diplex Oscillator B into REPR. Grounded TP78 on the RRWDS board.	Pass
DEFKA	Disconnected, then reconnected the weather station at top of DP, cabinet.	Pass
M4INOR M4ALA	Created an inhibit zone at menu 5.5.5. Manually interrogated with LDC toggle switch for 360 deg. Ten scans later, interrogated with LDC pushbutton. Ten scans later, cleared the inhibit zone. Data showed that M4INOR did not indicate that 360 operation was inhibited any time in the recording. M4ALA did not indicate an attempt to interrogate in an inhibit zone.	Fail Fail
RCVSTA	Induced soft and hard alarms on LNA #10 through threshold changes.	Pass
DPRIST	Loaded blank clear day map and changed Wx STC stop range to minimum value to induce RIB alarms,	Pass
SPSTAT	Induced Permanent Echo (PE) alarm in Sync. A. SPSTAT remained at 100% operational.	Fail
TXSTST	Changed thresholds to induce soft and hard alarms for transmitter Preamp #2.	Pass
TXLDST	Enabled all lookdown sectors (without lookdown function available).	Pass
TXABST	Changed threshold to induce a soft, then a hard alarm in the transmitter.	Pass
KGSTAT	Not Tested	

4.1.5 ARSR-4 to Power Subsystem.

Purpose
The purpose of this test was to assess the impact that site power interruptions have on the ARSR-4 data sent to the ARTCC.

Test Objectives

a. Verify that the ARSR-4 provides the means for maintaining any critical data necessary to restore the system to normal operation within 100 ms following restoration of power when primary power failure occurs for greater than 20 ms, but equal to or less than 15 seconds.

b. Verify that the restoration of normal operation is automatic and that all operational programs, fixed and dynamic maps, field and site adjustable parameter settings are preserved.

Test Description

Configuration
The ARSR-4 power design includes an isolation transformer for control of harmonic distortion. However, the ARSR-4 design does not provide the means for an uninterruptible supply of site power to the system.

The ARSR-4 is equipped with backup batteries for the Signal Processor and Data Processor. The batteries supply power to these cabinets for up to 15 seconds to maintain track data, Maps, and Site Adjustable Parameters (SAPs)/Field Adjustable Parameters (FAPs) during a short-term power loss.

Measures are also taken in the ARSR-4 software to maintain the system configuration during power loss. Upon detection of a power loss, the safe data and configuration segments are saved to Electrically Erasable Programmable Read Only Memory (EEPROM).

The Mt. Laguna ARSR-4 power configuration included an Ingersoll-Rand backup engine generator, set up to provide backup power within 10 seconds after detection of power loss. During one of the natural power losses at the site, a digital control board in the Ingersoll-Rand generator was damaged and the generator was subsequently replaced with a Caterpillar generator.

Setup
During OT&E, a BMI40 power analyzer was connected to the primary of the ARSR-4 isolation transformer. The analyzer monitored voltage and current for each of the three phases and compared this data to preset thresholds. Under normal power conditions (monitored values within thresholds), the analyzer saved a status report to disk at noon and midnight each day. When a power fluctuation occurred, the analyzer recorded more detailed data to disk at the time of the event. During some of the events, surveillance data was recorded using IRES connected to User 1 ports and ARSR-4 alarm and status data was recorded using the MPS monitor.

Power loss data was collected from two events, scheduled and nonscheduled power outages. Scheduled power outages were accomplished by turning off a circuit breaker (for approximately 10 seconds) and then turning the breaker back on. The time needed for the backup engine generator to start was noted along with any ARSR-4 anomalies during recovery.

Nonscheduled power outages were interruptions of power service to the site. These interruptions were most severe during storms on Mt. Laguna. Several times, one or more phases of power were dropped. On these occasions, "brownout" conditions were encountered when voltage levels fluctuated in and out of thresholds.

Data Analysis

The reaction of the ARSR-4 to a short term (< 15 seconds) power loss was observed. Any anomalies noted during the events were documented in the test log book at the radar site. These observations were correlated with power analyzer data, MPS monitor data, and IRES data when available.

Results

During the scheduled power losses, the engine generator was noted to start up in less than 10 seconds each time. However, during one nonscheduled event, a digital board in the Ingersoll-Rand generator was damaged and no backup power was supplied to the ARSR-4. The generator was later replaced with a Caterpillar generator.

The ARSR-4 recovery from both scheduled and nonscheduled power loss was inconsistent. Sometimes the system would recover properly, providing continuous stream of data to the user with no hardware damage or false BIT alarms. Other times, problems were noted. The significant problems are described below. It should be noted that several software builds were installed in the system throughout the test period. The ARSR-4 was observed to fail power loss recovery for tests conducted with various software builds including the final software build tested during OT&E.

Problem #1 Large number of false BIT alarms.

On many occasions, after a short-term power loss, BIT reported multiple false hard alarms. In most of these cases, a cold start (up to a 3-minute site outage) was needed to reset the alarms.

Problem #2 Large number of false search reports.

Occasionally, the ARSR-4 would output a large number of false search reports for up to one scan. The false alarms were displayed on the LDC and were also sent to the end user. Normal data reporting commenced after resynchronization at north.

Problem #3 Damage to hardware during power loss.

On two separate occasions, when one leg of power was lost to the site, hardware was damaged in the transmitter.

The first case occurred on May 5, 1995. The Basic Measurement Instruments (BMI) power analyzer was not connected at the time of the event. The power loss included a brownout condition where the voltage fluctuated. The blowers in the four bay cabinets made a loud choppy sound, giving the indication that a phase was lost. After power was restored to the site, BIT reported a damaged collector power supply in transmitter A. Further investigation confirmed the bad power supply.

Before the transmitter A collector power supply could be replaced, a second power loss occurred. Again, a brownout condition was experienced. The ARSR-4 main breaker was turned off at this point to avoid further damage to the equipment. The ARSR-3 continued to provide uninterrupted service to the end user. The ARSR-3 operates on an uninterruptible power supply (UPS) in conjunction with an engine generator.

After power was restored, 2 days later, a switcher module in a second collector power supply was found to be damaged, resulting in a soft alarm reported by BIT. The May 5 power disturbance was the suspected cause of the switcher module failure.

The second case occurred on May 13, 1995. The BMI power analyzer was connected to the isolation transformer primary during this event. The power disturbance was similar to the one experienced on May 5 (i.e., brownout condition). Figure 4.1.5-1 shows one snapshot of the BMI 40 data recorded during the event. The data shows the short-term drop of phase C-A voltage (upper trace in the figure) accompanied by a fluctuating phase C current (lower trace in the figure).

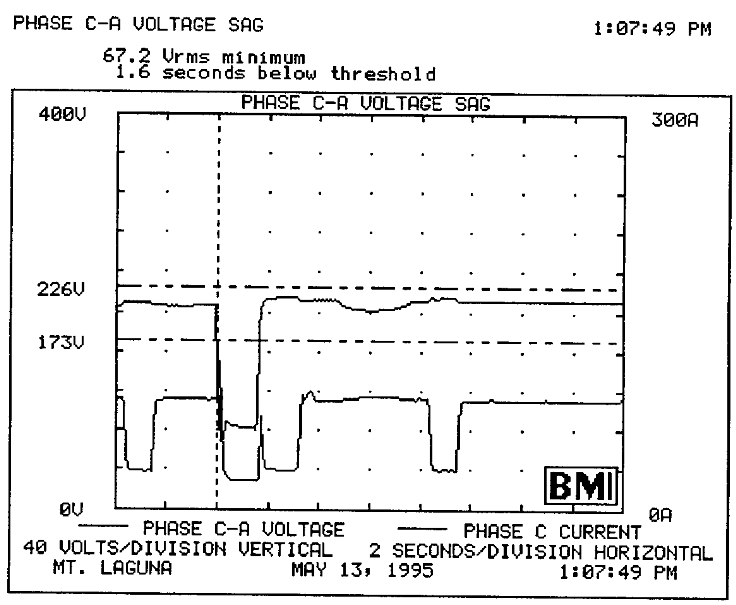

FIGURE 4.1.5-1. SITE POWER DATA - MAY 13, 1995

The ARSR-4 was turned off to avoid further equipment damage. Two days later, power was restored. After power restoration, two additional problems were apparent.

The first problem concerned a hard alarm reported for the 2:1:8 splitter in the transmitter. When the splitter was replaced, the unit contained water. It was suspected that the water entered the transmitter from the exhaust duct above.

Further investigation revealed that the louver motor did not close the louver for the exhaust duct when the system power was turned off. The louver motor battery was not charged. BIT does not monitor this battery, therefore, no alarms were reported to the user.

After the bad 2:1:8 splitter was replaced, BIT/Fault Isolation Tests (FIT) isolated a damaged bus regulator board in the transmitter.

Problem #4 No backup battery status monitoring.

During investigation into power loss problems on February 2, 1995, the circuit breakers on the Data Processor and Signal Processor cabinets were turned off to effect the power loss. The ARSR-4 recovered with multiple false BIT alarms. The RAPPI display on the LDC was also erratic. A cold start (up to a 3-minute site outage) was required to return the system to normal operation.

From this test, it was determined that some of the ARSR-4 power loss recovery problems were due to uncharged backup batteries for the Signal Processor and Data Processor. The reason for the uncharged batteries (either bad batteries, improper installation, or improper maintenance) was not determined. There is no ARSR-4 BIT monitoring of the backup battery voltages, therefore, the user was given no information concerning the health of the batteries.

Problem #5 Saving of incorrect safe data to EEPROM.

By design, when the ARSR-4 senses a power loss, safe data and configuration segments are saved to EEPROM. On one occasion, during a brownout condition, the data saved to EEPROM was corrupted. The corrupted information may be confusing to site technicians.

Problem #6 Increase of minor version numbers.

A less significant effect of a power loss is the increase in the minor version numbers for configuration and safe data segments on the main RMS menu. When the safe data and configuration segments are saved to EEPROM, the minor version numbers are increased for these segments. Therefore, if version numbers are used as a means to keep track of the configuration, power loss effects should be considered.

Conclusions

a. The ARSR-4, as configured at Mt. Laguna, did not consistently recover from a short-term power loss.

b. The backup engine generator may be damaged during a power disturbance, therefore only a reliable, tested engine generator should be used with the ARSR-4.

c. On many occasions, the ARSR-4 reported a large number of false BIT alarms after power loss. A cold start (resulting in a 3-minute data loss to the user) was often required to reset the alarms.

d. On several occasions after a short-term power loss, a large number of false search reports were output from the ARSR-4. The condition was reset after resynchronization at north.

e. When one or more phases of site power are dropped, transmitter hardware is often damaged. Although the transmitter hardware damaged during these events was redundant, the ARSR-4 came dangerously close to losing full search and weather capability. ARSR-4 hardware should not be damaged due to power surges or transients.

f. The isolation transformer designed on the ARSR-4 was installed for the control of harmonics into the system. It was not designed to provide protection from loss of a phase of power or power surges.

g. The ARSR-3 appeared unaffected during those natural power disturbances that caused damage in the ARSR-4 transmitter. The ARSR-3 is operated on an UPS.

h. There is no mechanism in the ARSR-4 for automatically monitoring the health of the backup batteries for the data processor and signal processor.

i. The safe data and configuration segments, routinely saved to EEPROM during a power loss can become corrupted during brownout conditions.

j. Minor version numbers will increment when the ARSR-4 detects a power loss and saves data to EEPROM.

Recommendations

a. The ARSR-4 should be operated with an UPS in addition to a reliable backup engine generator in order to avoid most of the problems described above.

b. There should be improvements made to BIT in order to monitor backup power supply voltages and report any alarms via the RMS. An alternative solution would be to increase the frequency of scheduled maintenance checks for the backup batteries.

c. ARSR-4 documentation should reflect the fact that minor version numbers may increase during a power loss due to the saving of safe data and configuration segments to EEPROM.

4.1.6 Surveillance Coverage.

Purpose

This test measures the primary and secondary radar detection capability throughout the specified coverage volume.

Test Objectives

a. Verify that the ARSR-4 detects and reports targets through 360° in azimuth.

b. Verify that the slant range coverage is from 5 to 250 nm.

c. Verify that the ARSR-4 reports height on targets through 360° in azimuth from 5 to 250 nm in range.

d. Verify that the elevation reporting coverage is from at least + 0.2 to 20° above the horizontal.

e. Verify that the beacon altitude coverage extends to 100,000 feet MSL.

Test Description

Target of opportunity data was used for coverage analysis. The data was collected at the CD-2 ports using an IRES recorder. Data was also collected from the commissioned ARSR-3 at Mt. Laguna with an MX-6A recorder during one of the tests. Since the RCS of the targets were unknown, no conclusions about the search detection can be drawn.

Three sets of data were recorded for coverage analysis. RUN497 was performed on June 5, 1995, at the beginning of the OT&E retest period. The data was recorded at the output of the first function tracker in the ARSR-4.

RUN535 was performed on July 7, 1995. Data was collected simultaneously on the ARSR-4 and the ARSR-3 (operating in simplex). The ARSR-4 data was collected at the output of the first function tracker. The effects of changes to geocensor stop range SAPs during OT&E regression were analyzed through comparison of RUN497 and RUN535 ARSR-4 data.

RUN600 was performed on July 18, 1995, during the certification flight check. The data was collected at the output of the ARSR-4 second function tracker.

System Configuration

SAPs were optimized during the first phase of OT&E. The parameters which have a direct impact on coverage performance are listed in this section. Unless stated otherwise, these parameters were consistent throughout testing.

ARSR-4 transmissions were blanked in the direction of the ARSR-3 to avoid interference with the operational radar. The blanked region spanned from 326.25° to 360°. The ARSR-3 transmitter was blanked in the direction of the ARSR-4 (from approximately 160°to 180°).

Two different methods were used to disable beacon operation in the direction of the ARSR-3 tower during OT&E. A beacon blanker was initially set up on the ATCBI-5 to interrupt mode pair trigger transmission to the ARSR-4 at the blanked azimuths. The blanker was effective in eliminating the adverse effects of beacon reflections from the ARSR-3 tower. However, the interruption of timing signals to the beacon blanker during synchronizer reconfigurations caused an error in the blanker and loss of data. The error would clear and normal operation would resume at the next ARP signal.

At the start of OT&E regression, the beacon blanker was disconnected from the ATCBI-5. Instead, a military map was set up in the ARSR-4 from 330° to 359.9°. Beacon reports were deleted in the formatter in this region.

The ARSR-4 provides a lookdown beam for low elevation coverage at high sites (above 6500 feet elevation). However, this option was not used at Mt. Laguna (6238 feet MSL) due to excessive number of clutter false alarms with its use.

Additional site specific parameters effecting coverage include antenna tilt, Sensitivity Time Control (STC) settings, and Geocensor map configuration. The search antenna tilt was set at +0.630°.

STC was employed to reduce the saturating effects of nearby clutter returns. The STC slope and stop range are user adjustable per sector and beam. The slope was set to 12 dB per octave for each sector. The STC stop ranges in nautical miles are shown in table 4.1.6-1.

The geocensor map (filename 8JLGEO) was set up during optimization. Geocensoring attenuates returns in selected range/azimuth cells to control false alarms from road traffic or excessively strong point clutter. The map resolution is 1/8 nm by 1.4° and extends from 5 to 126 nm. Each cell can have one of eight possible thresholds.

Figure 4.1.6-1 shows the ARSR-4 geocensor map for Mt. Laguna. A large geocensor region was configured east of the radar around the El Centro area. The region spanned from approximately 35 to 100 miles in range and 60° to 115° in azimuth (i.e., sectors 5 through 10). Geocensoring was used in an attempt to suppress strong clutter returns over the desert.

The maximum range in each sector for which geocensor levels are applied is user selectable via SAP/FAPs. This range selection is common to beams 2 through 5. The maximum range for each sector is shown in table 4.1.6-2.

TABLE 4.1.6-1. STC STOP RANGE

	Receive Beam									
SECTOR	1	2	3	4	5L	5H	6	7	8	9
0	151	160	160	142	127	85	85	85	82	75
1	151	160	160	142	127	85	85	85	82	75
2	151	160	160	142	127	85	85	85	82	75
3	151	160	160	142	127	85	85	85	82	75
4	151	160	160	142	127	85	85	85	82	75
5	151	160	160	142	127	85	85	85	82	75
6	151	160	160	142	127	85	85	85	82	75
7	151	160	160	142	127	85	85	85	82	75
8	151	160	160	142	127	85	85	85	82	75
9	151	160	160	142	127	85	85	85	82	75
10	151	160	160	142	127	85	85	85	82	75
11	151	160	160	142	127	85	85	85	82	75
12	151	160	160	142	127	85	85	85	82	75
13	151	160	160	142	127	85	85	85	82	75
14	151	160	160	142	127	85	85	85	82	75
15	151	160	160	142	127	85	85	85	82	75
16	151	160	160	142	127	85	85	85	82	75
17	126	117	117	101	101	85	85	85	82	76
18	126	117	117	101	101	85	85	85	82	76
19	126	117	117	101	101	85	85	85	82	76
20	126	117	117	101	101	85	85	85	82	76
21	126	117	117	101	101	85	85	85	82	76
22	126	117	117	101	101	85	85	85	82	76
23	126	117	117	101	101	85	85	85	82	76
24	126	117	117	101	101	85	85	85	82	76
25	126	117	117	101	101	85	85	85	82	76
26	126	117	117	101	101	85	85	85	82	76
27	151	160	160	142	127	85	85	85	82	75
28	151	160	160	142	127	85	85	85	82	75
29	151	160	160	142	127	85	85	85	82	75
30	151	160	160	142	127	85	85	85	82	75
31	151	160	160	142	127	85	85	85	82	75

TABLE 4.1.6-2. GEOCENSOR RANGE GATE BY SECTOR

SECTOR	RANGE	SECTOR	RANGE	SECTOR	RANGE	SECTOR	RANGE
0	126.0	8	30.0	16	126.0	24	126.0
1	126.0	9	30.0	17	126.0	25	126.0
2	126.0	10	126.0	18	126.0	26	126.0
3	126.0	11	126.0	19	126.0	27	126.0
4	126.0	12	126.0	20	126.0	28	126.0
5	126.0	13	126.0	21	126.0	29	126.0
6	126.0	14	126.0	22	126.0	30	126.0
7	30.0	15	126.0	23	126.0	31	126.0

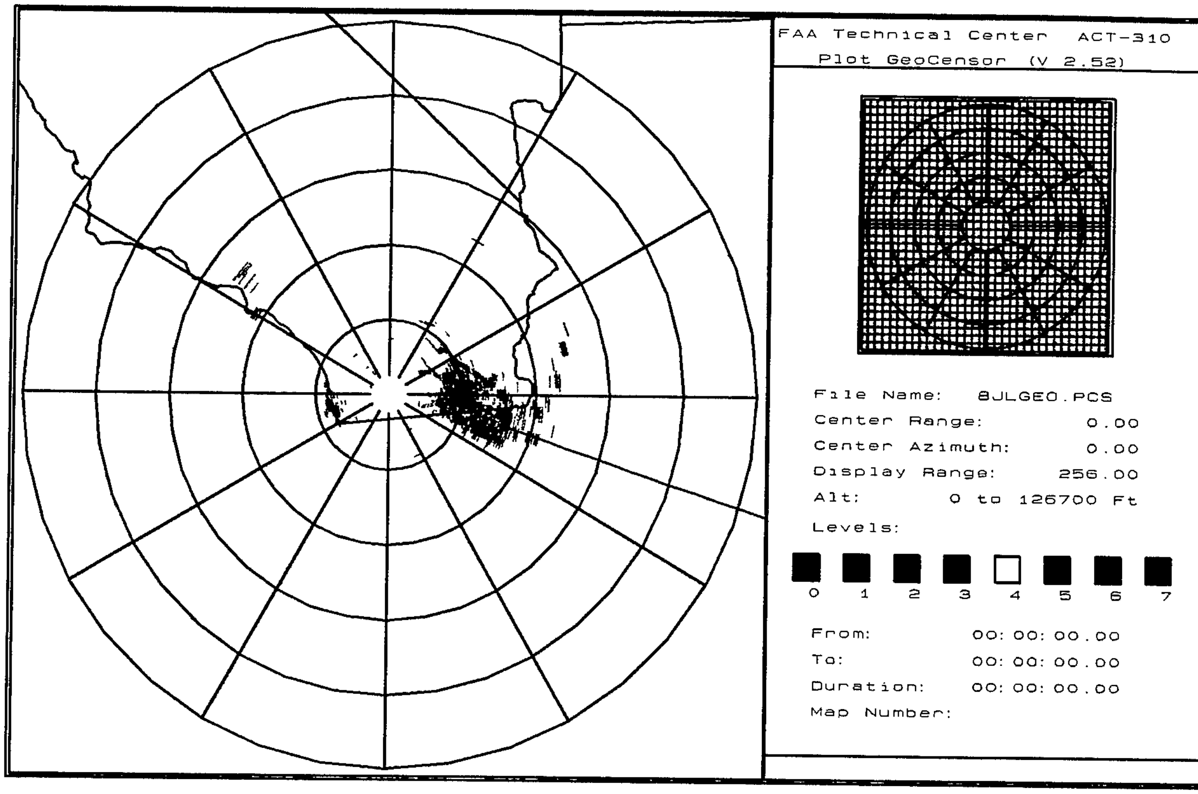

FIGURE 4.1.6-1 ARSR-4 GEOCENSOR MAP

Data Analysis

Coverage analysis was performed using IRES. The data was first sorted into range, azimuth and height order for each scan using the PREPPCS program. The data was then tracked using TRACK, an alpha-beta tracker in IRES. The QUALIFY program then compared the resultant tracks to a predetermined set of criteria (e.g., minimum track age, minimum distance travelled, percent beacon, etc.) to determine the status of each track (true, false, or unknown).

The FILTER program separated the track data into true and false track files. The true track file was then used for coverage analysis.

The true track data was plotted using the PLOTPCS and PLOTRHI programs. PLOTPCS presents a PPI plot of range versus azimuth. These plots present the minimum and maximum range of coverage at all azimuth angles. PLOTRHI plots reports in a range versus height format. The radar antenna height and 4/3 earth curvature are taken into account. In each plot, areas of reduced search detection are apparent by a lower reinforcement rate.

Results

Figure 4.1.6-2 presents a PLOTPCS plot (100 scans) of the true tracks during RUN497. The black tracks show search reinforced beacon reports. Blue tracks represent beacon reports with no reinforcement. The blanked region is clearly shown spanning from 326° to 0°in azimuth. From the figure, it is evident that the ARSR-4 provides good inner and outer range coverage for primary and secondary targets from 0 to 326° in azimuth.

Figure 4.1.6-3 shows an Range Height Indicator (RHI) plot for RUN 497. The plot shows that the ARSR-4 provides adequate search and beacon detection at altitudes within its coverage range. The reinforced tracks show that the ARSR-4 provides coverage from below the 0° elevation angle through 30°.

Inspection of figures 4.1.6-2 and 4.1.6-3 reveal areas where nonreinforced reports are prevalent. This indicates either reduced search detection or terrain shielding. In figure 4.1.6-2, two areas of reduced search detection are evident. The higher nonreinforced rate in the first area (to the west of the radar at approximately 50 nm), is primarily the result of beacon detection on transponder equipped ships in the San Diego harbor. Reduced search detection in this area is not an operational concern.

The second small region of nonreinforced tracks is shown between 35 and 75 nm in range and 60 and 120° in azimuth. Figure 4.1.6-4 shows this area in greater detail. Comparison of figures 4.1.6-1 and 4.1.6-2 shows that the low search detection is in the same area as the highest levels of geocensoring.

To improve search detection in this area, the maximum range for geocensoring in sectors 6 through 9 was decreased on June 27, 1995. This effectively reduced the attenuation in the area of concern. The new values are shown in table 4.1.6-3.

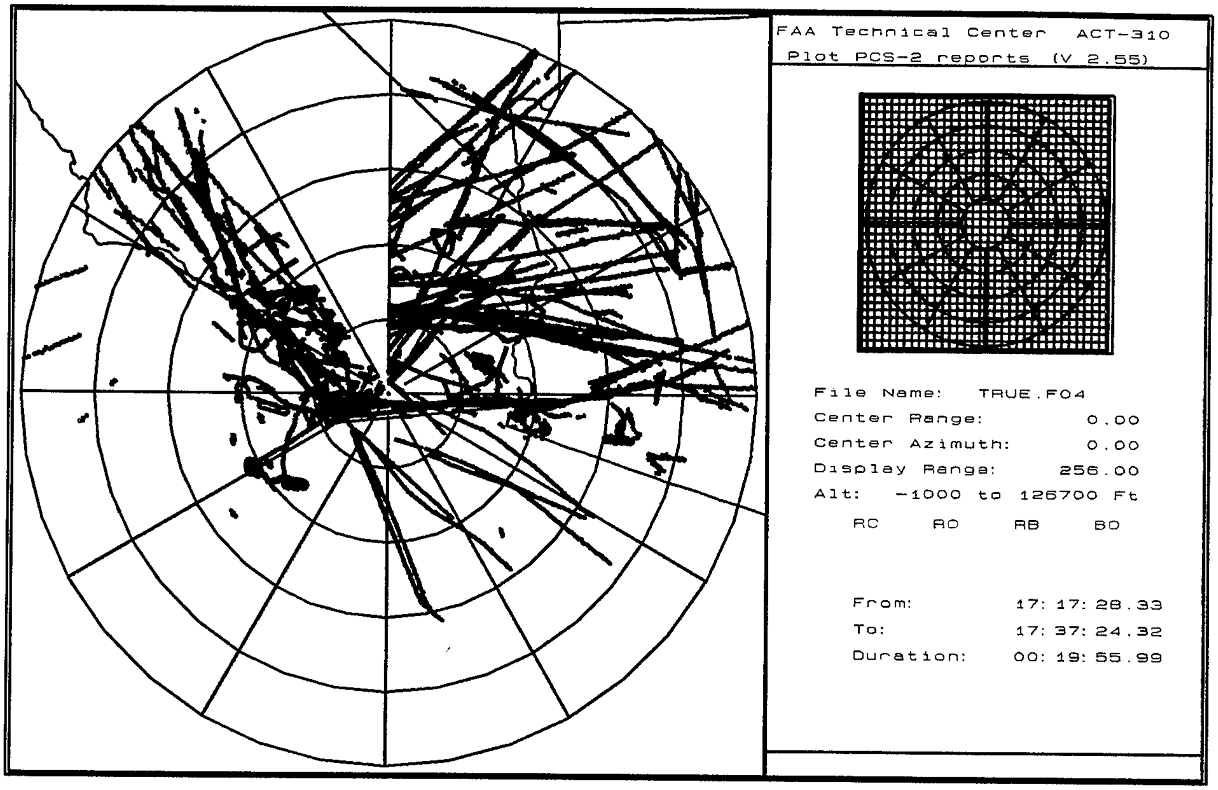

FIGURE 4.1.6-2 RUN497 PLOTPCS COVERAGE - 100 SCANS

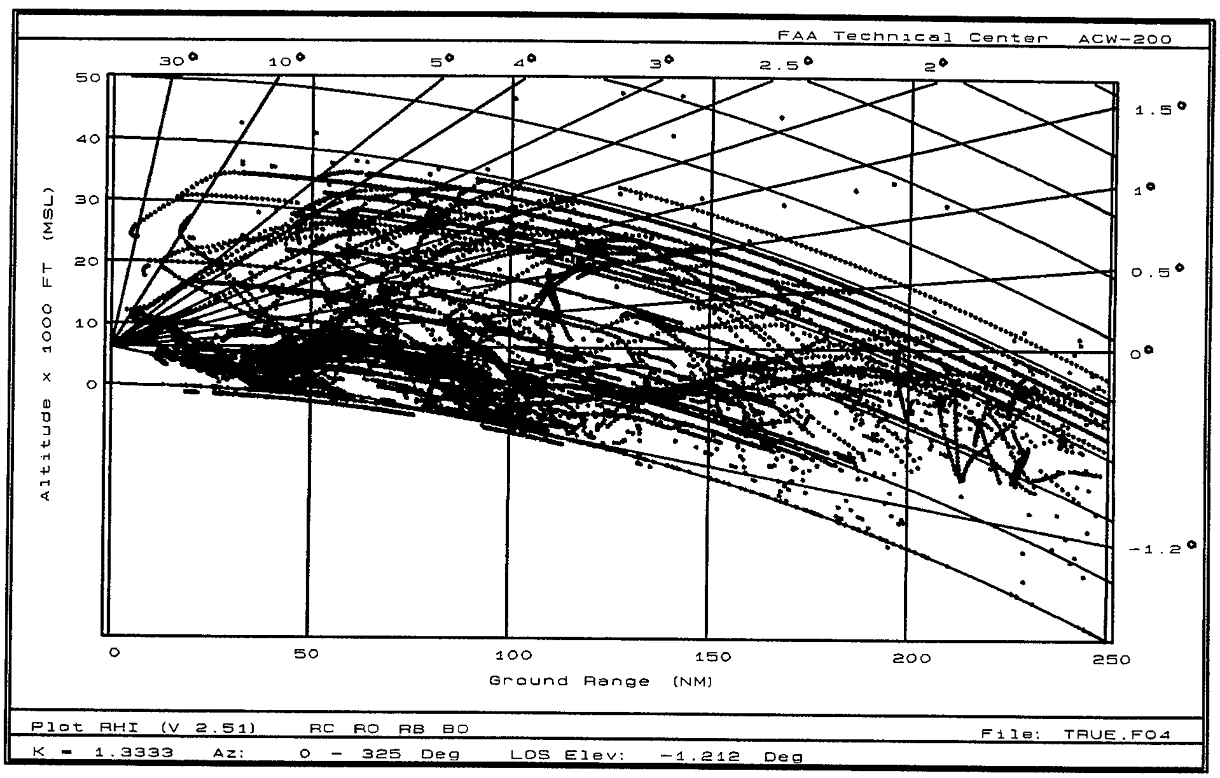

FIGURE 4.1.6-3 RUN497 PLOTRHI COVERAGE - 100 SCANS

TABLE 4.1.6-3. GEOCENSOR STOP RANGE CHANGES

SECTOR	RANGE (nm)
6	40
7	25
8	25
9	25

After the geocensor stop range changes, a second test (RUN 535) was performed on July 7, 1995. Figure 4.1.6-5 plots the beacon only and reinforced reports for RUN 535 in the area to the east of the radar. The data was recorded for approximately 1 hour and 20 minutes. The figure shows many beacon only tracks, indicating low search detection in the area.

Figure 4.1.6-6 shows an RHI plot for the region where the coverage hole exists. The vast majority of nonreinforced reports are shown below zero degree elevation. Terrain shielding most likely contributes to the lower search detection in this area. Excessive geocensoring (needed to control the false alarm rate) is also a contributor. Additional data showing the effects of geocensoring on search test targets can be found in the Surveillance Capacity and Delay section of this report.

RUN 535 contained data recorded simultaneously from the ARSR-4 and ARSR-3. Figure 4.1.6-7 plots ARSR-3 reports in the area to the east of the radar. The ARSR-3 (operating in simplex) revealed the same reduced detection as the ARSR-4.

Comparison of figure 4.1.6-7 with 4.1.6-5 shows that the ARSR-4 beacon detection in the area was better than the ARSR-3. Several solid ARSR-4 beacon only tracks show only sparse beacon detection on the ARSR-3.

Table 4.1.6-4 shows that the ARSR-4 output a higher number of reinforced reports than the ARSR-3 in the area to the east of the radar. The ARSR-4 reinforcement rate is lower than the ARSR-3 due to better ARSR-4 beacon only reporting. The results show that ARSR-4 and ARSR-3 search detection were both low over the mountains to the east of the radar. However, the ARSR-4 provided better beacon detection in that region. Therefore, it is concluded that the ARSR-4 provides adequate coverage in that area for operational use.

TABLE 4.1.6-4. RUN 535 - ARSR-4 VS. ARSR-3

	ARSR-4	ARSR-3
Beacon Reports	5187	4853
Reinforced	3575	3458
Beacon Only	1612	1395
Reinforcement Rate	68.9%	71.3%

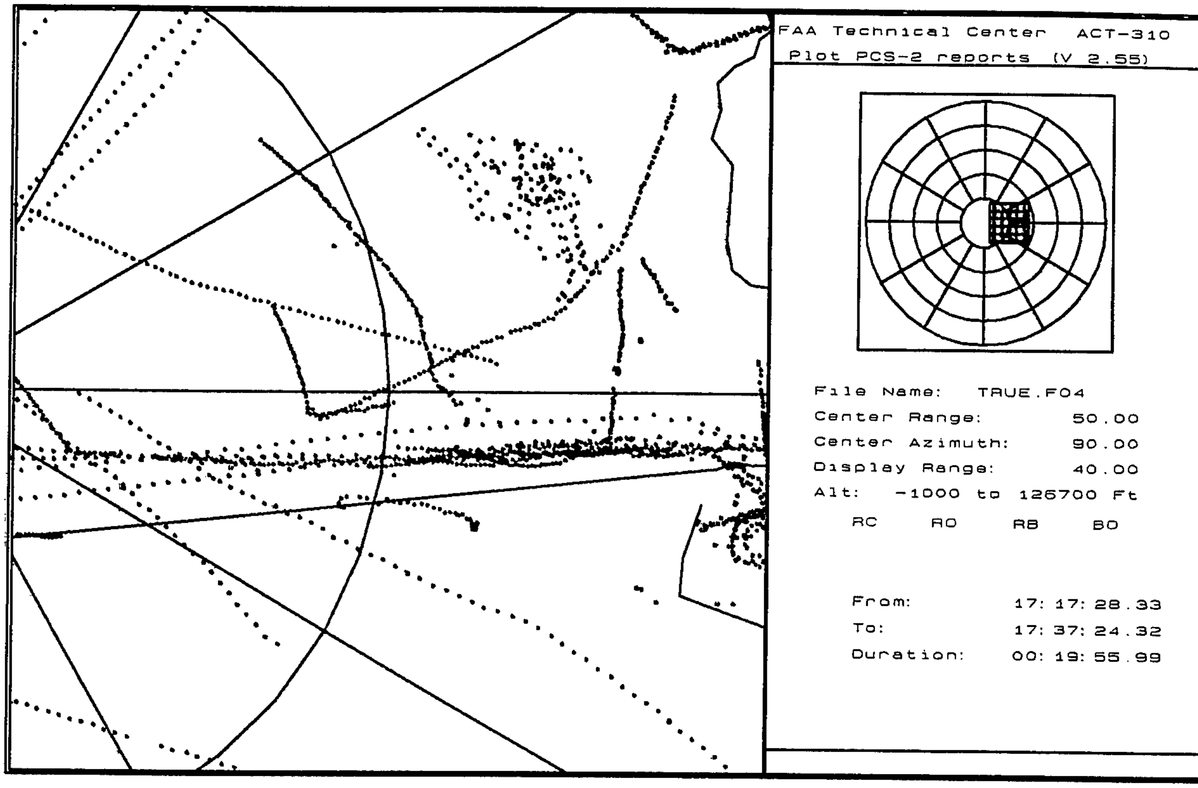

FIGURE 4.1.6-4 RUN497 COVERAGE IN GEOCENSORED AREA

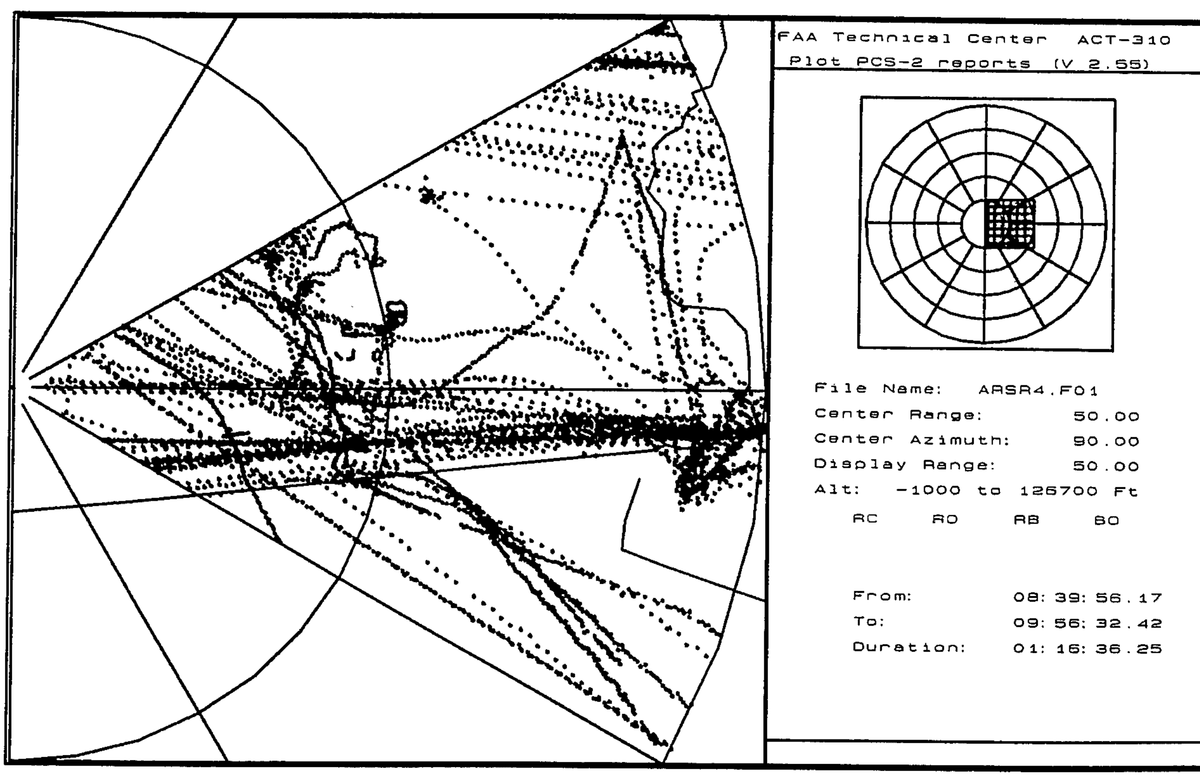

FIGURE 4.1.6-5 RUN535 ARSR-4 AFTER GEOCENSOR CHANGES

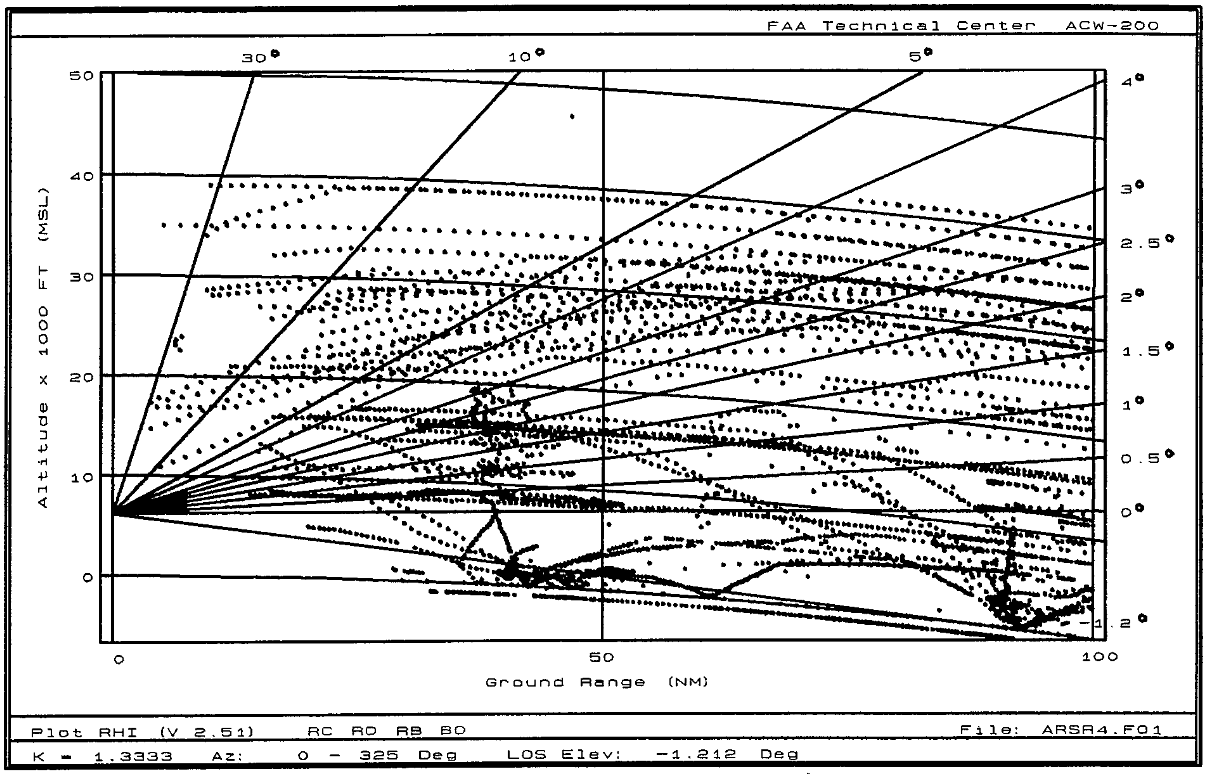

FIGURE 4.1.6-6 RUN 535 PLOTRHI IN GEOCENSORED AREA

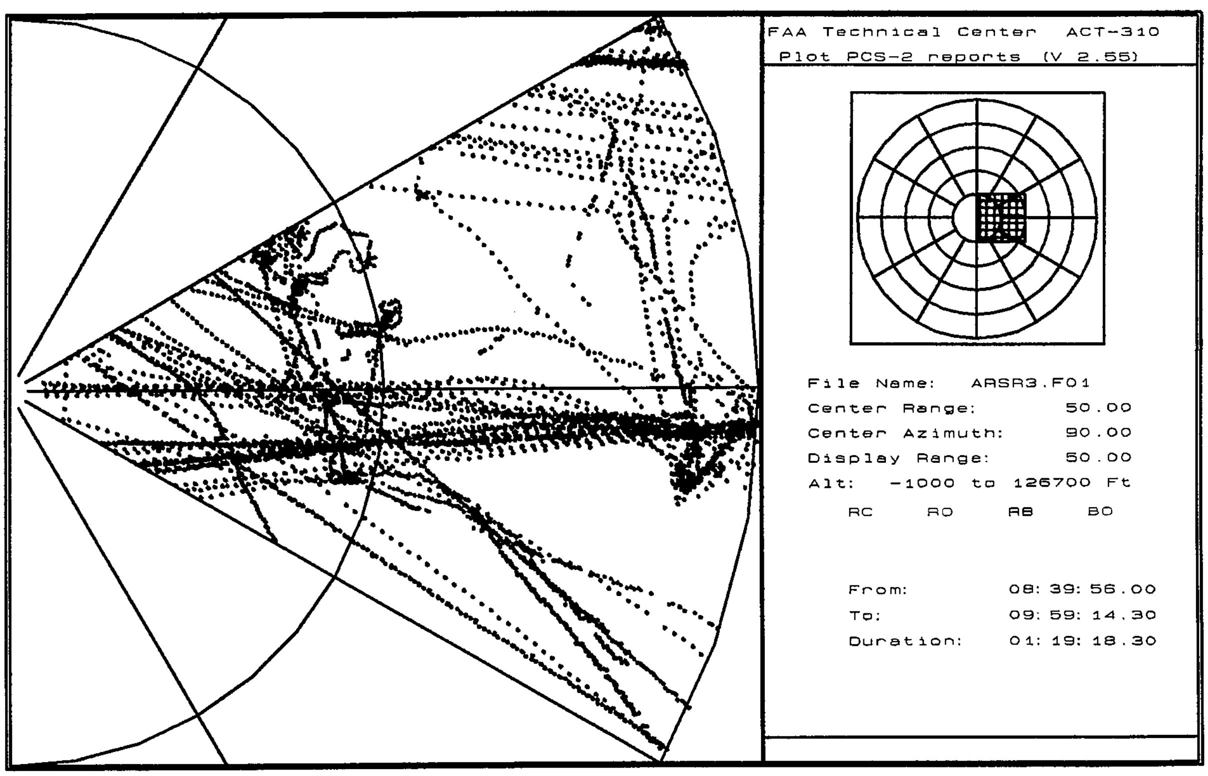

FIGURE 4.1.6-7 ARSR-3 COVERAGE

RUN 600 data was collected during the certification flight check on July 18, 1995. The second function tracker was enabled. This will be the operational configuration for the Mt. Laguna ARSR-4. Figures 4.1.6-8 and 4.1.6-9 show the search and beacon coverage for the true tracks from IRES. The radar reinforcement rate during the test was 83.5 percent, indicating good search and beacon detection.

Conclusions

a. The ARSR-4 provides the air traffic controller with suitable primary and secondary radar data within the required coverage volume.

b. The ARSR-4 detects primary and beacon targets from 5 nm to 250 nm. The ARSR-4 provides a 50 nm increase in range coverage when compared to the ARSR-3.

c. The ARSR-4 provides coverage from 0 through 326° in azimuth. The blanked area will be tested when the ARSR-3 tower is removed.

d. Analysis of target of opportunity data showed that the ARSR-4 provides coverage at elevation angles from below 0 degrees to 30° and altitude coverage to 45,000 feet.

e. A hole in primary detection was revealed between 35 and 75 miles in range and 60 and 120° in azimuth. The hole was caused by a combination of excessive geocensoring in the area and terrain shielding. High levels of geocensoring were needed to control the search false alarm rate. This resulted in attenuating the returns of real targets. The ARSR-3 (operating in simplex) experienced the same loss of search detection in the area. The ARSR-4 provided better beacon detection than the ARSR-3 in the area.

4.1.7 Surveillance Detection.

Radar target detection tests were divided into three segments. First, the operational subclutter visibility (SCV) of the ARSR-4 was measured by positioning a search test target over a near saturating point of clutter. Next, T-38 test aircraft flew along a radial at various altitudes to verify 2.2 square meter detection requirements. Finally, a Convair 580 test aircraft flew the air routes within Mt. Laguna coverage at minimum enroute altitudes to ensure that the ARSR-4 detection was acceptable in these areas.

4.1.7.1 Subclutter Visibility.

Purpose

Ensure that the ARSR-4 can adequately detect a moving target whose amplitude is well below the amplitude of the surrounding clutter.

Test Objective

Determine the ARSR-4 subclutter visibility.

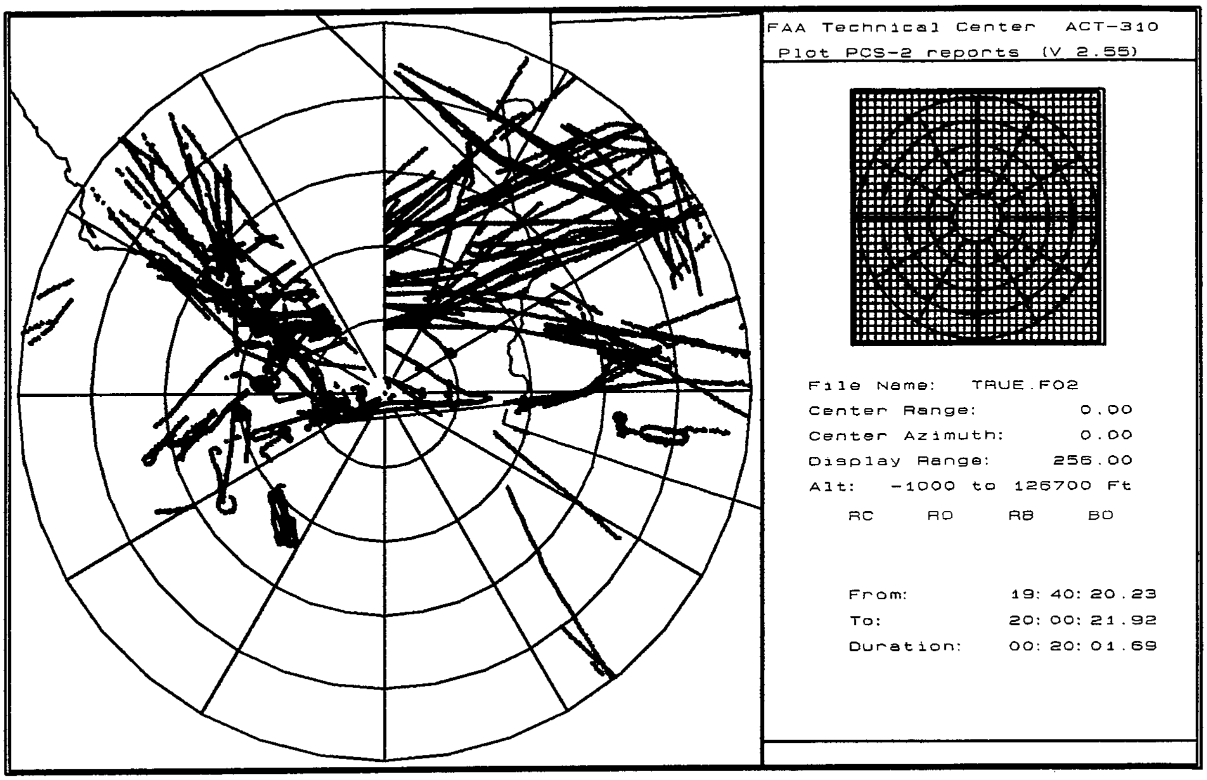

FIGURE 4.1.6-8 RUN 600 ARSR-4 PLOTPCS COVERAGE - 100 SCANS

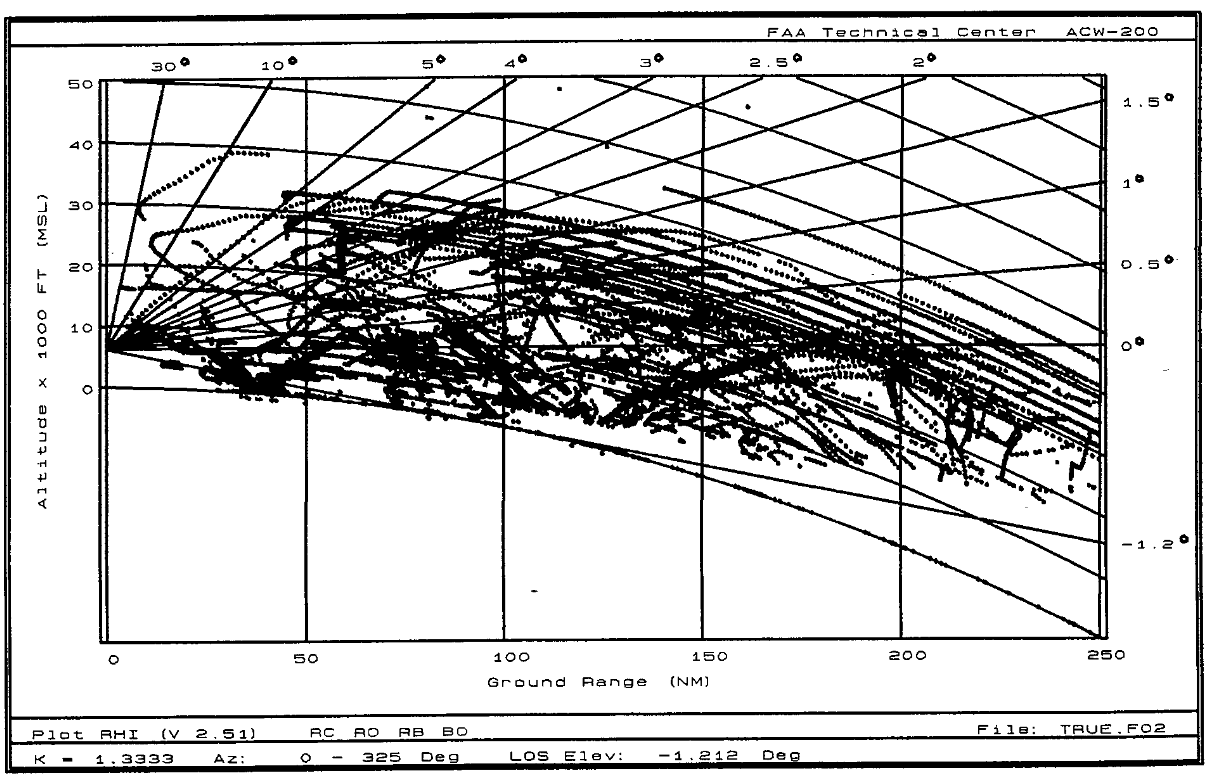

FIGURE 4.1.6-9 RUN 600 ARSR-4 PLOTRHI COVERAGE - 100 SCANS

Test Description

The Phase II Development Test and Evaluation (DT&E) SCV test was repeated during OT&E at Mt. Laguna. The SCV measurement was performed once. The measurement was made with the 25MAY95 build installed in the system.

A near limiting point clutter source was identified to the southeast of the radar (in sector 13). The STC end range in sector 13 was reduced from 160 to 80 for beam 2 to ensure that the clutter was near but not into saturation. The clutter amplitude was determined through adjustment of the video level filters via menu 2.10 on the LDC/RMS.

A search test target with a doppler velocity of 500 knots was positioned over the clutter video on the LDC. The second function velocity threshold was set to zero to enable a search RAPPI indication for the test target on the LDC.

Several iterations of search test target amplitude adjustment were needed to determine the SCV. At each test target amplitude, the blip scan for the test target was measured on the LDC RAPPI over a period of ten scans. The SCV was the difference (in dB) between the measured clutter amplitude and the search test target amplitude at which a 0.8 blip scan was obtained for the test target.

Results

The measured SCV was 51 dB. This result compares favorably with the Phase II DT&E test result of 50 dB.

Conclusions

Although there is no SCV requirement in FAA-2763B, the measured value indicates that the ARSR-4 provides sufficient detection performance in operational clutter environments.

4.1.7.2 Primary Target Detection - 2.2 Square Meter Target.

Purpose

Ensure that the ARSR-4 can detect a 2.2 square meter target throughout the coverage volume with adequate beacon detection for Air Traffic (AT) use.

Test Objectives

a. Verify, through dedicated flight tests, that the ARSR-4 can detect a 2.2 square meter target at least 80 percent of the time at distances from 5 to 200 nm.

b. Verify that the beacon percent detection for the flight test aircraft exceeds 80 percent within the coverage range of the radar (5 to 250 nm).

Test Description
Detection requirements for a 2.2 square meter target were verified during Phase II DT&E through flight tests using a T-38 test aircraft. The T-38 has a radar cross section of approximately 2.2 square meters. The T-38 flew inbound and outbound along the 314° radial of the Mt. Laguna ARSR-4 at various altitudes. The flight radial is shown in figure 4.1.7.2-1.

Fourteen T-38 detection flights were performed between October 25 and October 30, 1993. Table 4.1.7.2-1 shows the T-38 flight tests performed. Each flight was designated with a run number. Seven T-38 flights were conducted between 150 and 235 nm from the radar at 39000 feet MSL. Two flights were conducted between 0 and 150 nm at 19000 feet MSL. Five flights were conducted between 0 and 200 nm at 39000 feet MSL. ARSR-4 detection when operated in three differing frequency modes (VIP, Pulse Agile Mode (PAM), and Burst Agile Mode (BAM)) was measured. CD-2 data was recorded from the ARSR-4 output ports with the IRES recorder during each flight.

TABLE 4.1.7.2-1. T-38 FLIGHT TESTS

Run	Range (nm)	Altitude (ft MSL)	ARSR-4 Mode	# of Radials
1, 3, 4	150-235	39000	VIP1	8 Inbound 8 Outbound
9, 10	150-235	39000	PAM	6 Inbound 6 Outbound
11,12	150-235	39000	BAM	5 Inbound 5 Outbound
13, 14	0-150	19000	VIP1	5 Inbound 5 Outbound
17 - 21	0-200	39000	VIP1	5 Inbound 5 Outbound

Data Analysis
Data reduction and analysis for the detection tests were performed with IRES. First, each recorded file was filtered, using the IRES FILTER program, to keep only the data around the radial of interest. The data was then sorted into range, azimuth, and height order using the PREPPCS program.

Next, the flight test aircraft was tracked using SELECT, a selective alpha-beta tracker in IRES. SELECT initiates track on the beacon code of interest, but updates tracks on search or beacon reports. Aircraft turns were then filtered out of the file using FILTER.

Finally, PLOTPD presented detection results in the form of radar and beacon detection histograms. Each bar in the chart shows the percent detection in a 5-mile range window. The 80 percent detection line represents the minimum detection level required for a 2.2 square meter target.

The data presented in each histogram was smoothed by averaging the percent detection over three range bins so the detection for range bin N is the average of the raw percent detections for range bins N-1, N, and N+1. Since no requirements were specified for separate inbound and outbound detection characteristics, composite in/out detection histograms were generated.

Results

The composite radar and beacon percent detection histograms for detection flights from 150 - 235 nm are shown in figure 4.1.7.2-2 and table 4.1.7.2-2.

TABLE 4.1.7.2-2. PERCENT DETECTION, RUNS 1, 3-4

Range (NM)	Opp	Radar Hits	Radar Raw %	Radar Smooth %	Beacon Hits	Beacon Raw %	Beacon Smooth %
150.0	22	21	95	94	22	100	93
155.0	49	46	94	97	44	90	90
160.0	47	47	100	97	40	85	86
165.0	44	43	98	99	36	82	84
170.0	47	47	100	99	40	85	83
175.0	47	47	100	98	38	81	82
180.0	46	43	93	96	37	80	84
185.0	46	44	96	94	42	91	85
190.0	47	44	94	94	39	83	85
195.0	44	41	93	91	36	82	83
200.0	49	43	88	94	41	84	84
205.0	48	48	100	94	41	85	85
210.0	46	43	93	94	39	85	80
215.0	44	39	89	91	31	70	79
220.0	47	43	91	87	38	81	74
225.0	47	38	81	89	33	70	74
230.0	49	46	94	91	35	71	73
235.0	43	43	100	96	33	77	69
240.0	48	46	96	84	28	58	66
245.0	31	14	45	73	19	61	61
250.0	6	2	33	0	5	83	0

The data in figure 4.1.7.2-2 showed good outer range radar detection. The radar 80 percent detection threshold was maintained to a range of 241.9 nm, well beyond the 200 nm requirement.

Beacon percent detection exceeded 80 percent until 211.4 nm, then dropped as the range of the test aircraft increased. The objective of 80 percent beacon detection to 250 nm was not met for the flight test aircraft. The beacon percent detection was less than expected throughout the tests due to suspected shielding of the beacon antenna on the test aircraft at outer ranges.

The percent detection histogram of the combined results for RUNS 9 and 10 is shown in figure 4.1.7.2-3 and table 4.1.7.2-3. The graph shows acceptable target detection when the ARSR-4 operated in BAM. The composite radar percent detection drops below 80 percent at 232.2 nm. The beacon percent detection for RUNS 9 and 10 exceeded 80 percent out to 231.1 nm.

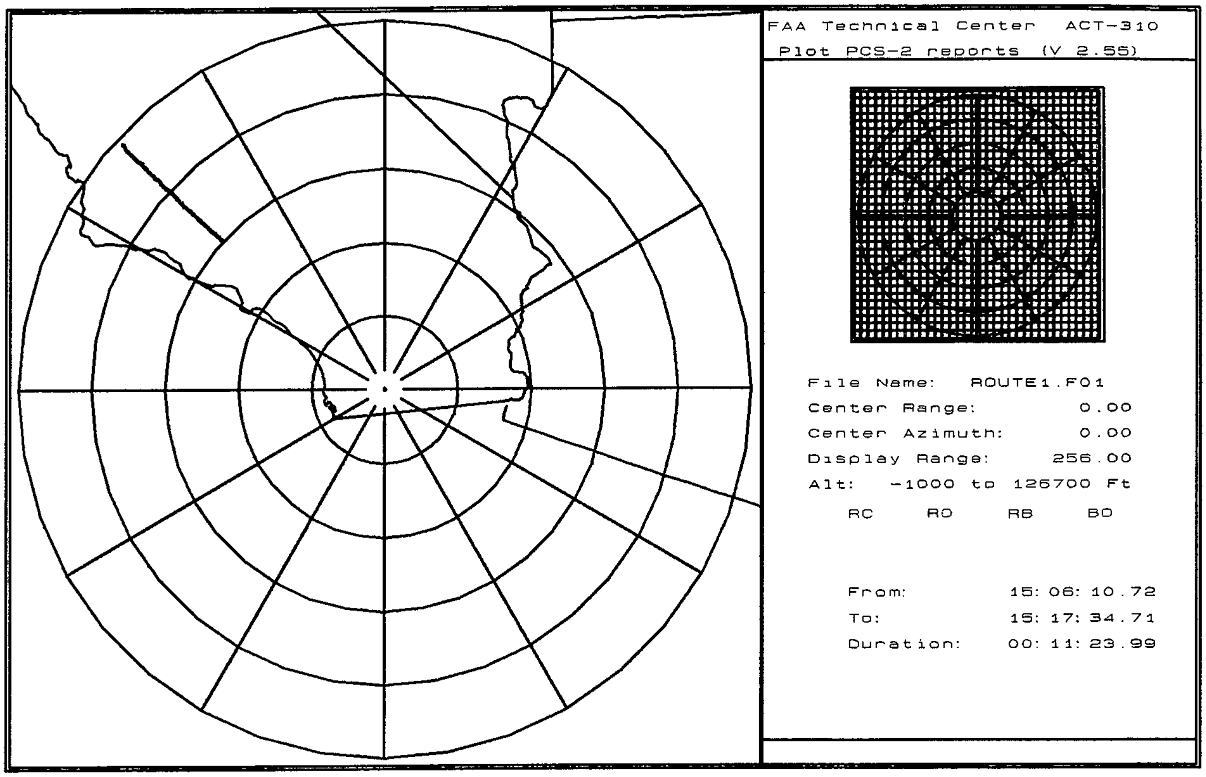

FIGURE 4.1.7.2-1 T-38 FLIGHT TEST RADIAL

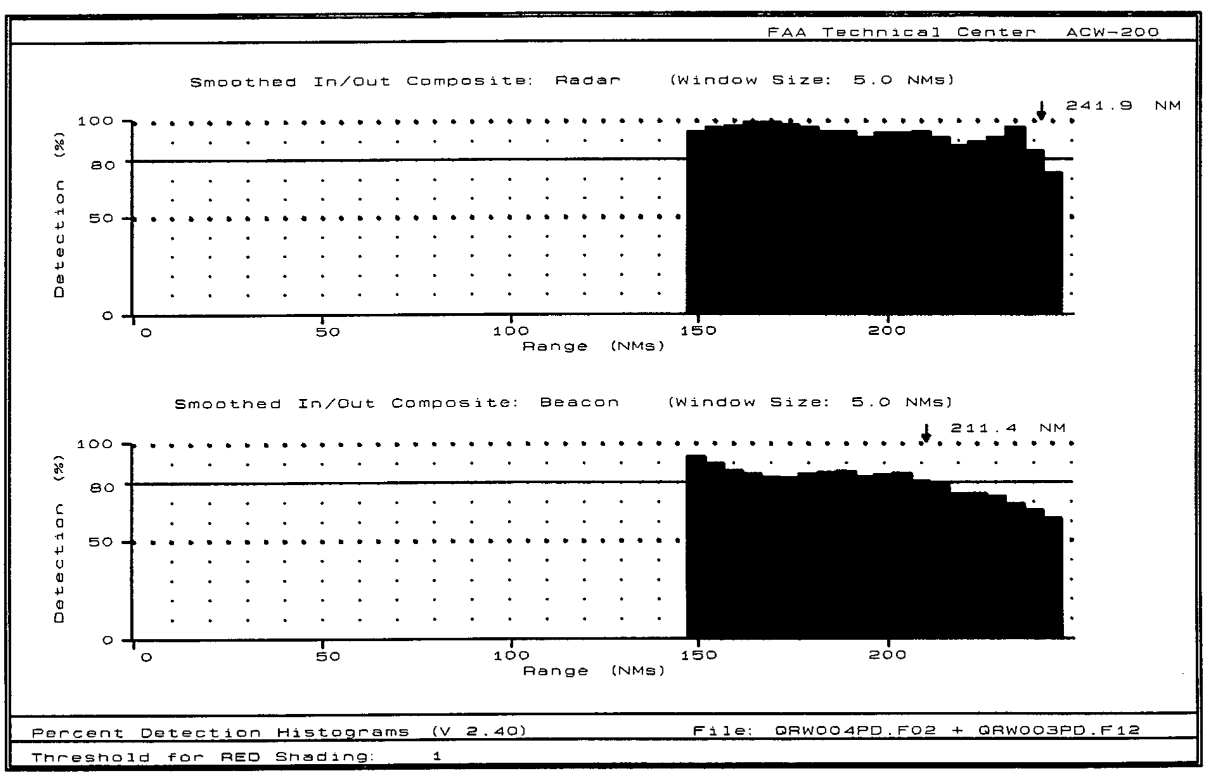

FIGURE 4.1.7.2-2 COMPOSITE PERCENT DETECTION, RUNS 1, 3-4, VIP1 MODE

TABLE 4.1.7.2-3. PERCENT DETECTION, RUNS 9, 10

Range (NM)	Opp	Radar Hits	Radar Raw %	Radar Smooth %	Beacon Hits	Beacon Raw %	Beacon Smooth %
150.0	11	10	91	96	11	100	100
155.0	17	17	100	98	17	100	100
160.0	21	21	100	100	21	100	100
165.0	17	17	100	100	17	100	100
170.0	20	20	100	100	20	100	100
175.0	18	18	100	100	18	100	100
180.0	18	18	100	100	18	100	98
185.0	19	19	100	100	18	95	98
190.0	19	19	100	100	19	100	98
195.0	18	18	100	96	18	100	100
200.0	19	17	89	96	19	89	96
205.0	19	19	100	93	17	89	93
210.0	19	17	89	95	17	94	91
215.0	18	17	94	88	17	90	91
220.0	20	16	80	89	18	100	95
225.0	19	18	95	88	19	100	93
230.0	18	16	89	84	16	89	86
235.0	19	13	68	75	13	68	69
240.0	15	10	67	68	7	47	59

The percent detection histogram of the results for RUNS 11 and 12 is shown in figure 4.1.7.2-4 and table 4.1.7.2-4. The graphs show acceptable radar target detection when operating in PAM. The composite radar percent detection drops below 80 percent at 214.2 nm. The beacon percent detection drops below 80 percent at 231.1 nm.

The percent detection histogram of the composite results of RUNS 13 and 14 is shown in figure 4.1.7.2-5. The ARSR-4 provided good detection which was well above 80 percent from 5 to 150 nm. Beacon percent detection was close to 100 percent throughout the coverage area.

The percent detection histogram of the composite results of RUNS 17 through 21 is shown in figure 4.1.7.2-6. The ARSR-4 provided good detection results throughout the area. There is, however, a drop in the detection area between 105 and 115 nm. The drop in detection was caused by geocensoring in that area.

Conclusions

The ARSR-4 exceeded specification requirements for primary percent detection of a 2.2 square meter target for each of the transmit frequency modes and at each altitude tested.

The beacon detection performance for the test aircraft did not meet the objective of 80 percent detection to 250 nm. The lower, far range beacon percent detection was suspected to be due to shielding of the test aircraft beacon antenna during the test. In addition, since these flights were

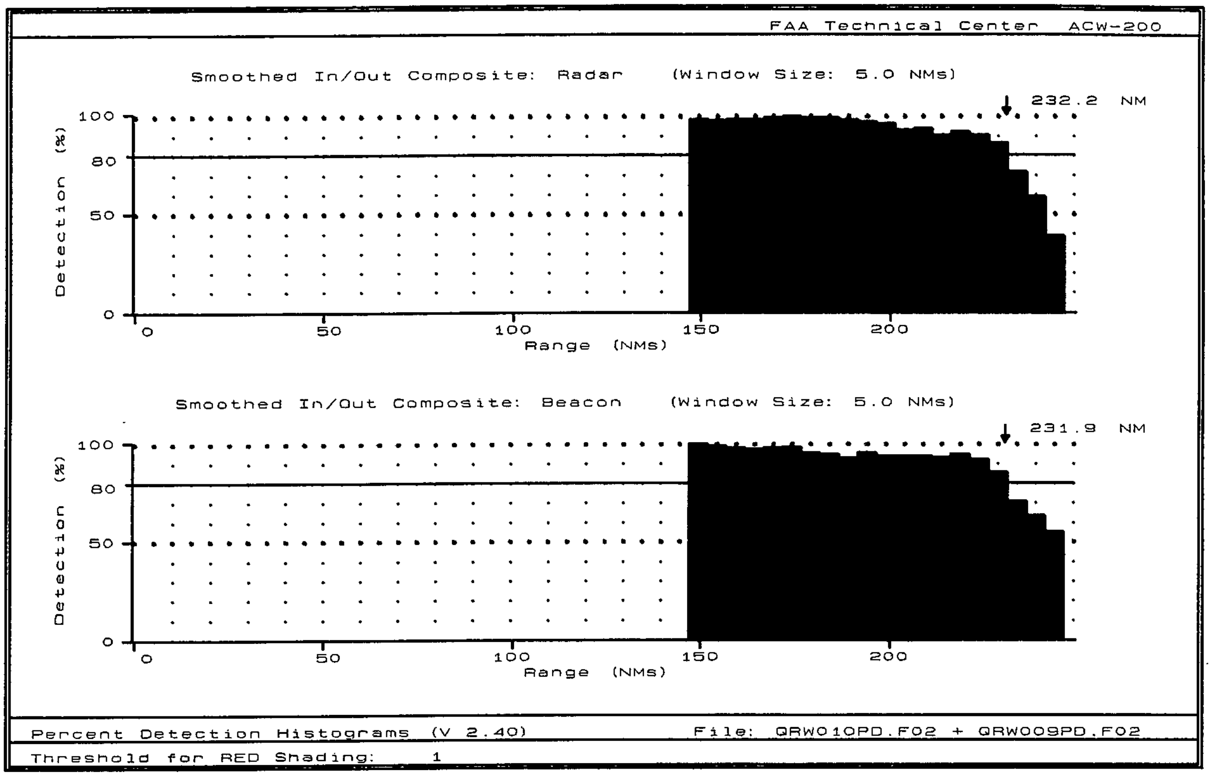

FIGURE 4.1.7.2-3 COMPOSITE PERCENT DETECTION, RUNS 9-10, PAM MODE

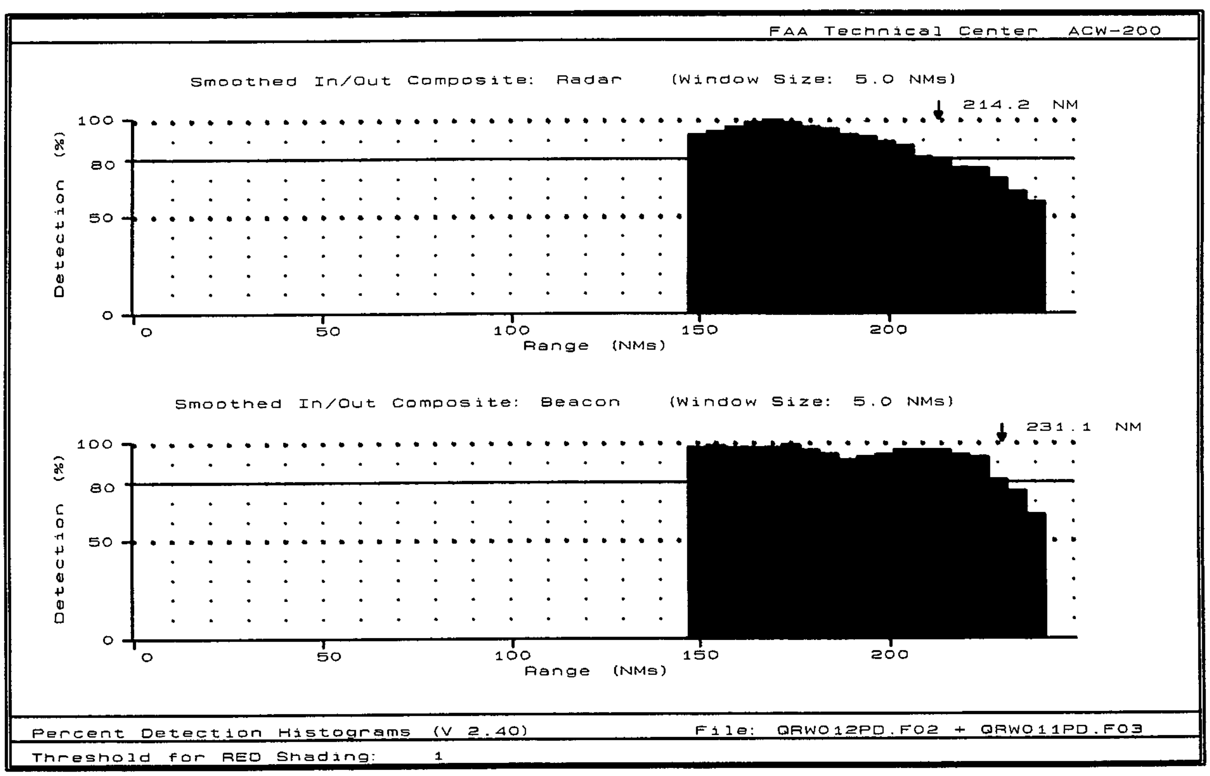

FIGURE 4.1.7.2-4 COMPOSITE PERCENT DETECTION, RUNS 11-12, BAM MODE

performed at the end of DT&E, the beacon detection is not representative of the optimized system tested during OT&E. The beacon outer range coverage for the OT&E configuration is addressed in the Surveillance Coverage section of the report.

TABLE 4.1.7.2-4. PERCENT DETECTION, RUNS 11, 12

Range (NM)	Opp	Radar Hits	Radar Raw %	Radar Smooth %	Beacon Hits	Beacon Raw %	Beacon Smooth %
150.0	14	13	93	93	13	93	98
155.0	27	25	93	94	27	100	99
160.0	29	28	97	96	29	100	98
165.0	28	28	100	99	26	93	98
170.0	27	27	100	100	27	100	98
175.0	27	27	100	99	27	100	99
180.0	31	30	97	96	30	97	96
185.0	27	25	93	95	25	93	94
190.0	29	28	97	93	27	93	91
195.0	26	23	88	92	23	88	93
200.0	28	25	89	89	27	96	94
205.0	28	25	89	87	27	96	96
210.0	29	21	83	81	28	97	96
215.0	28	20	71	80	27	96	96
220.0	27	23	85	76	26	96	94
225.0	27	19	70	75	24	89	93
230.0	27	19	70	70	25	93	81
235.0	26	18	69	63	16	62	75
240.0	12	4	33	58	8	67	63

TABLE 4.1.7.2-5. PERCENT DETECTION, RUNS 13 AND 14

Range (NM)	Opp	Radar Hits	Radar Raw %	Radar Smooth %	Beacon Hits	Beacon Raw %	Beacon Smooth %
5.0	19	10	53	73	19	100	100
10.0	29	25	86	82	29	100	100
15.0	28	27	96	94	28	100	100
20.0	29	29	100	99	29	100	100
25.0	30	30	100	98	30	100	100
30.0	27	25	93	93	27	100	100
35.0	29	25	86	86	29	100	100
40.0	29	23	79	87	29	100	100
45.0	28	27	96	87	28	100	100
50.0	30	26	87	91	30	100	100
55.0	28	25	89	91	28	100	100
60.0	28	27	96	92	28	100	100
65.0	28	25	89	91	28	100	100
70.0	29	25	86	87	29	100	99
75.0	25	21	84	87	24	96	99
80.0	25	23	92	91	25	100	99
85.0	26	25	96	96	26	100	100
90.0	27	27	100	96	27	100	100
95.0	23	21	91	94	23	100	100
100.0	27	24	89	93	27	100	100
105.0	25	25	100	96	25	100	100
110.0	28	28	100	91	28	100	100
115.0	23	16	70	86	23	100	100
120.0	27	23	85	84	27	100	100
125.0	26	25	96	93	26	100	100
130.0	28	27	96	96	28	100	100
135.0	23	22	96	96	23	100	100
140.0	28	27	96	97	28	100	100
145.0	25	25	100	97	25	100	100
150.0	15	14	93	98	15	100	100

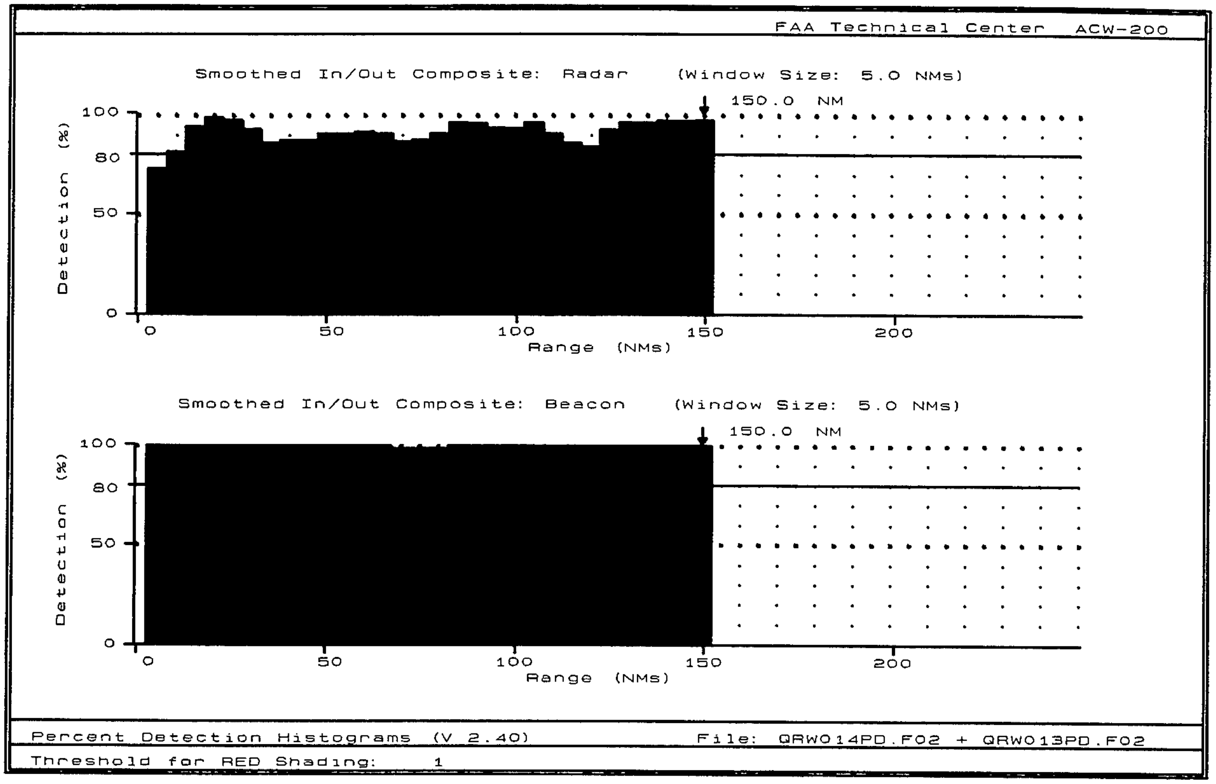

FIGURE 4.1.7.2-5 COMPOSITE PERCENT DETECTION, RUNS 13-14

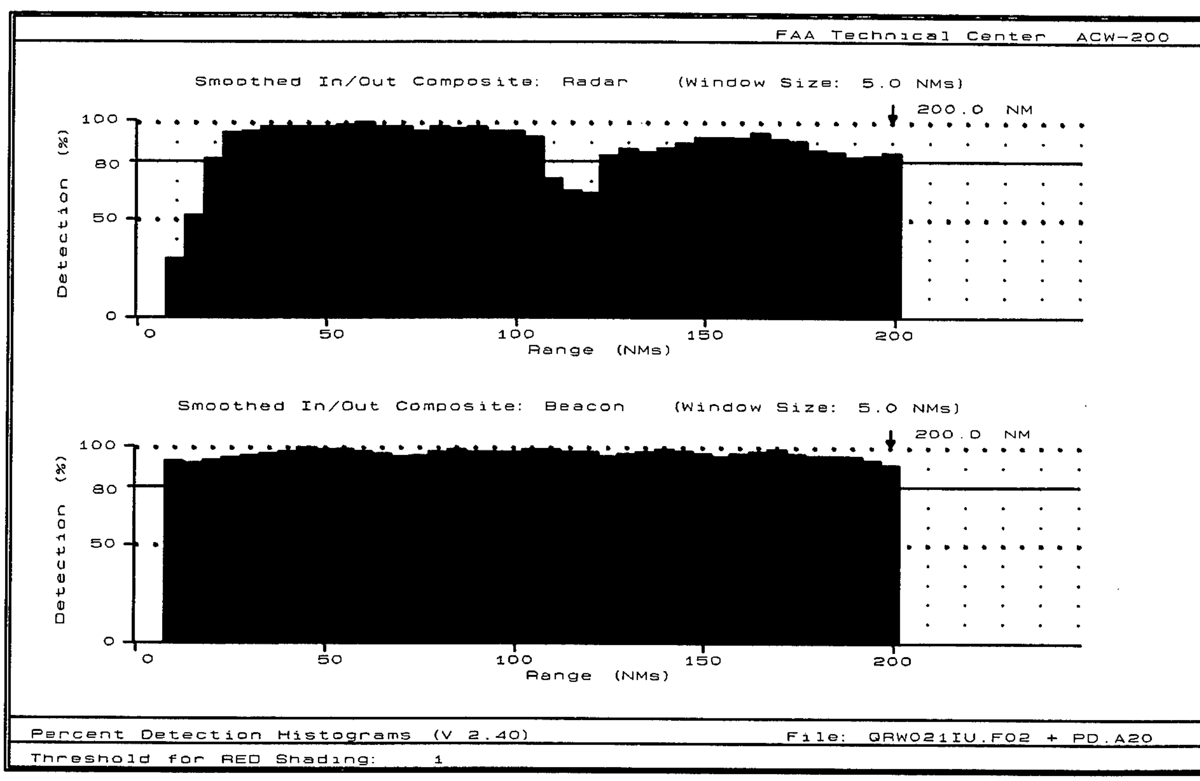

FIGURE 4.1.7.2-6 COMPOSITE PERCENT DETECTION, RUNS 17-21

TABLE 4.1.7.2-6 PERCENT DETECTION, RUNS 17-21

Range (NM)	Opp	Radar Hits	Radar Raw %	Radar Smooth %	Beacon Hits	Beacon Raw %	Beacon Smooth %
10.0	27	0	0	30	25	93	93
15.0	30	17	57	52	28	93	92
20.0	31	29	94	81	28	90	93
25.0	30	28	93	95	29	97	95
30.0	34	33	97	96	33	97	96
35.0	28	27	96	98	26	93	97
40.0	32	32	100	98	32	100	98
45.0	28	27	96	98	28	100	100
50.0	33	32	97	98	33	100	99
55.0	29	29	100	99	28	97	99
60.0	31	31	100	100	31	100	98
65.0	30	30	100	98	29	97	97
70.0	29	27	93	98	27	93	96
75.0	30	30	100	96	29	97	96
80.0	33	31	94	98	32	97	98
85.0	28	28	100	97	28	100	99
90.0	32	31	97	98	32	100	98
95.0	27	26	96	96	25	93	98
100.0	32	30	94	95	32	100	98
105.0	29	28	97	92	29	100	99
110.0	32	28	88	71	31	97	99
115.0	29	8	28	65	29	100	98
120.0	30	23	77	64	29	97	98
125.0	29	25	86	83	28	97	96
130.0	30	26	87	86	28	93	97
135.0	29	25	86	85	29	100	98
140.0	32	26	81	87	32	100	99
145.0	30	28	93	89	29	97	98
150.0	30	28	93	92	29	97	97
155.0	30	27	90	92	29	97	96
160.0	29	27	93	92	27	93	97
165.0	29	27	93	94	29	100	98
170.0	32	31	97	91	32	100	99
175.0	29	24	83	90	28	97	97
180.0	31	28	90	86	29	94	96
185.0	30	25	83	85	29	97	96
190.0	30	24	80	82	29	97	96
195.0	29	24	83	83	27	93	93
200.0	16	14	88	84	14	88	91

4.1.7.3 Primary Target Detection - Routes and Fixes.

Purpose

Ensure that the ARSR-4 can detect aircraft along known air routes in the Mt. Laguna coverage volume.

Test Objective

Verify that the ARSR-4 detects the test aircraft at least 80 percent of the time when flying at minimum enroute altitudes.

Test Description

Flight tests were performed along defined air routes between fixes at minimum enroute altitudes. These flights simulated the actual traffic patterns of commercial, general aviation, and military aircraft in the area. The 28JUN94 software build was installed in the ARSR-4 for the test.

A CV-580 was the test aircraft. Although the RCS of the CV-580 is approximately 22-square meters (head on), the aspect of the aircraft relative to the radar changed throughout the test and no conclusions can be drawn concerning the detection of a 22-square meter target.

Three flight tests were performed to test detection along the air routes. RUN159 and RUN160 were performed on August 10, 1994. RUN161 was performed on August 11, 1994. The run numbers, routes flown and altitudes are shown in table 4.1.7.3-1. The aircraft flew between the following fixes: San Diego (SAN), NIKKL, Thermal (TRM), Blythe (BLH), Parker (PKE), Needles (EED), Twenty Nine Palms (TNP), Julian (JLI), Imperial (IPL), Yucca, Canno, and Bard (BZA). CD-2 data was collected at the ARSR-4 user 1 ports with IRES.

TABLE 4.1.7.3-1. DETECTION ROUTES/ALTITUDES FLOWN

RUN159		RUN160		RUN161	
Route From-To	Alt. (Ft.)	Route From-To	Alt. (Ft.)	Route From-To	Alt. (Ft.)
SAN-NIKKL	5000	SAN-CANNO	8500	SAN-JLI	9000
NIKKL-TRM	11000	CANNO-JLI	8500	JLI-TRM	9000
TRM-BLH	7000	JLI-BLH	7000	TRM-BLH	7000
BLH-PKE	6000	BLH-TNP	8000	BLH-PKE	6000
PKE-EED	6000	TNP-EED	8000	PKE-EED	6000
EED-TNP	8000	EED-PKE	8000	EED-TNP	8000
TNP-TRM	7000	PKE-TRM	9000	TNP-BLH	8000
TRM-JLI	9000	TRM-BLH	8000	BLH-TRM	7000
JLI-IPL	8000	BLH-BZA	5000	TRM-PKE	9000
IPL-TRM	4000	BZA-IPL	4000	PKE-TRM	9000
TRM-Yucca	9000	IPL-JLI	8000	TRM-JLI	12000
Yucca-TNP	9000	JLI-NIKKL	10000	------	-----
TNP-TRM	12000	------	-----	------	-----

Data Analysis

Data reduction and analysis was performed with IRES. Each recorded file was sequenced into range, azimuth and height order using the PREPPCS program. The flight check aircraft was tracked using SELECT, a selective tracker program. False tracks were subsequently removed with the FILTER program.

Radar blip scan percentages for the test aircraft were calculated. The number of radar reports were counted and divided by the total number of opportunities (i.e., the number of scans that the aircraft was flying along the routes). Those scans where the test aircraft flew through the ARSR-4 blanked sector (330° to 0°) were not counted as opportunities.

Results

Figure 4.1.7.3-1 shows the flight pattern of the CV-580 for RUN159. The ARSR-4 provided good detection of the test aircraft along the routes with the exception of two locations.

Search detection was degraded in an area east of the radar site (from 35 nm to 85 nm and 90° to 115°). This loss of detection was caused by large levels of geocensoring which were utilized to reduce the search false alarm rate over the desert. The geocensor effects on detection are further discussed in the coverage section of this report. Detection was also degraded in the NEEDLES area (125 nm to 150 nm between 30° and 50°). This drop in detection was most likely due to screening by mountains in this area.

Table 4.1.7.3-2 shows the radar blip scan percentages for RUNS 159-161. The blip scan percentages calculated for a composite of all data files exceeded 80 percent. Overall, the percent detection for radar was at least 86 percent.

TABLE 4.1.7.3-2. RADAR AND BEACON DETECTION FOR CV-580

RUN	Opportunities	Radar Hits	Radar PD (%)
159	789	702	89
160	784	672	[illegible]6
161	806	749	93

Conclusions

a. The ARSR-4 provided good search detection along the air routes at minimum enroute altitudes except over the desert to the east of the site and in the NEEDLES area.

b. The drop in detection over the desert was caused by excessive geocensoring. The effects of geocensor map reoptimization in July 1995, to reduce detection loss in this area are further discussed in the Surveillance Coverage section of this report.

c. The drop in detection in the NEEDLES area is most likely caused by shielding by mountains in that area.

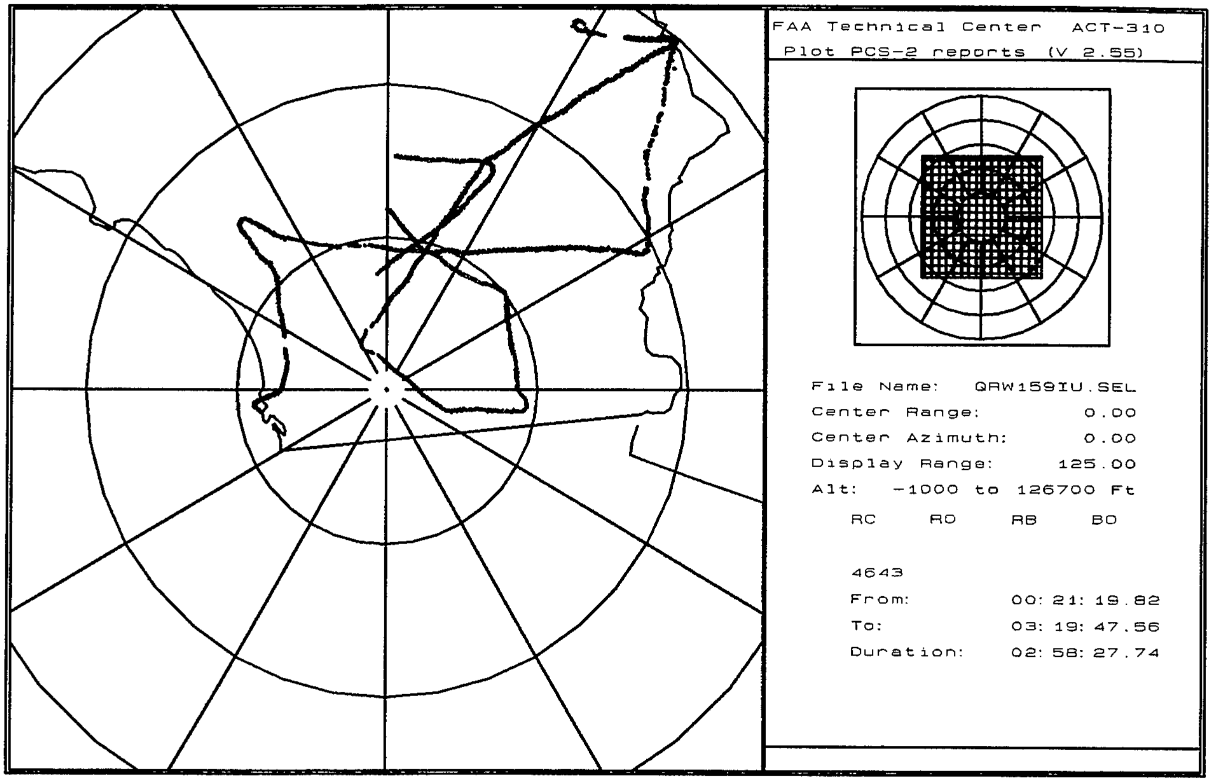

FIGURE 4.1.7.3-1 FLIGHT PATH OF CV-580 FOR RUN 159

4.1.8 Primary False Alarm Rate.

Purpose

Verify that the false alarm rate is operationally acceptable for use in enroute ATC.

Test Objective

a. Verify that the number of false reports per scan at the output of the first function of the scan-to-scan correlator function does not exceed a total of 194 from all causes.

b. Verify that the second function reduces the false report rate to 10 percent or less of that at the output of the first function.

Test Description

Target of opportunity data was collected at the AF1 and AF2 user ports using IRES. Three tests measured the ARSR-4 false alarm rate. Table 4.1.8-1 lists the tests along with the ARSR-4 and ARSR-3 configurations.

TABLE 4.1.8-1. FALSE ALARM DATA SETS

Run	ARSR-4 TX	ARSR-4 Mode	ARSR-4 Second Function	ARSR-3 TX
446	On	VIP/LP	No	Off
597	On	VIP/LP	Yes	Simplex

Run 446 was performed overnight on May 30, 1995. The ARSR-3 was not transmitting during the test. The ARSR-4 operated in VIP1 mode. Data at the output of the first function tracker was recorded.

Run 597 contains 200 scans of data recorded at the output of the second function tracker. The ARSR-4 operated in VIP mode with linear polarization. The ARSR-3 operated in simplex.

Data Analysis

The recorded data was analyzed using the IRES Track Quality Assessment (TQA) programs. Additional information on these programs can be found in appendix B. The data was first tracked using TRACK, an alpha-beta tracker in IRES. The QUALIFY program then compared the resultant tracks to a predetermined set of criteria (e.g., minimum track age, minimum distance travelled, percent beacon, etc.) to determine the status of each track (true, false, or unknown).

The PLOTTQA track editor program was used to verify that the true and false status assigned to the tracks by QUALIFY was correct. Also, the unknown tracks were manually reclassified as true or false after further study using PLOTTQA. The COUNTTRK program produced true and false report data counts.

The FILTER program separated the true and false reports into different files and also removed the beacon reports from the data sets. The PLOTSCAN program plotted the false search report counts versus scan number. PLOTPCS plotted the reports in a PPI format.

Results

Figure 4.1.8-1 shows the search reports per scan for Run 446 for an approximate 12-hour period from 2000 to 0800. The plot includes both true and false search reports. The data shows a reduction in report counts in the early morning hours and the subsequent increase in counts after day break. The search counts never exceeded 194 per scan for an extended period of time.

The Run 446 data was filtered to include 1 hour of data from 0700 to 0800. The data was then tracked and qualified in IRES. Figure 4.1.8-2 shows the false search reports per scan. The results showed 138 false search reports per scan averaged over 300 scans at the first function output. This number is well below the specified 194 per scan. The reinforcement rate during the 300 scan data set was good (88.7 percent) indicating a good search detection rate.

Figure 4.1.8-3 shows 100 scans of the false tracks for Run 446 in a PPI plot. The majority of the false search reports are the result of clutter breakthrough in the desert (to the east of the radar) and in the San Diego area (to the west).

Figure 4.1.8-4 shows all search reports per scan recorded during Run 597 (200 scans) at the output of the second function tracker. Comparison of figure 4.1.8-4 with figure 4.1.8-1 shows a significant reduction in the number of search reports per scan when the second function tracker was employed.

The number of false search reports per scan for Run 597 after tracking is shown in figure 4.1.8-5. There were 30 false search reports per scan averaged over the 200-scan file. The radar reinforcement rate was good (83.3 percent).

The false search report count exceeded the 10 percent requirement out of the second function tracker (i.e., greater than 19 per scan). Some of the false reports may be due to the operation of the ARSR-3 in simplex during the test.

The false reports for 100 scans of RUN 597 (after IRES analysis) are plotted in figure 4.1.8-6. Comparison of the figure with figure 4.1.8-3 (also 100 scans) shows a noticeable reduction in the number of false reports at the second function output.

The false reports at the second function output were more concentrated in the areas of strong clutter. Several iterations of geocensor map optimization were needed to find the best compromise between search detection and false report rate, particularly in the desert to the east of the radar. Any attempt to further reduce the false report rate (to meet the "10 percent of first function" requirement) by increasing geocensor levels in those areas may adversely impact search detection.

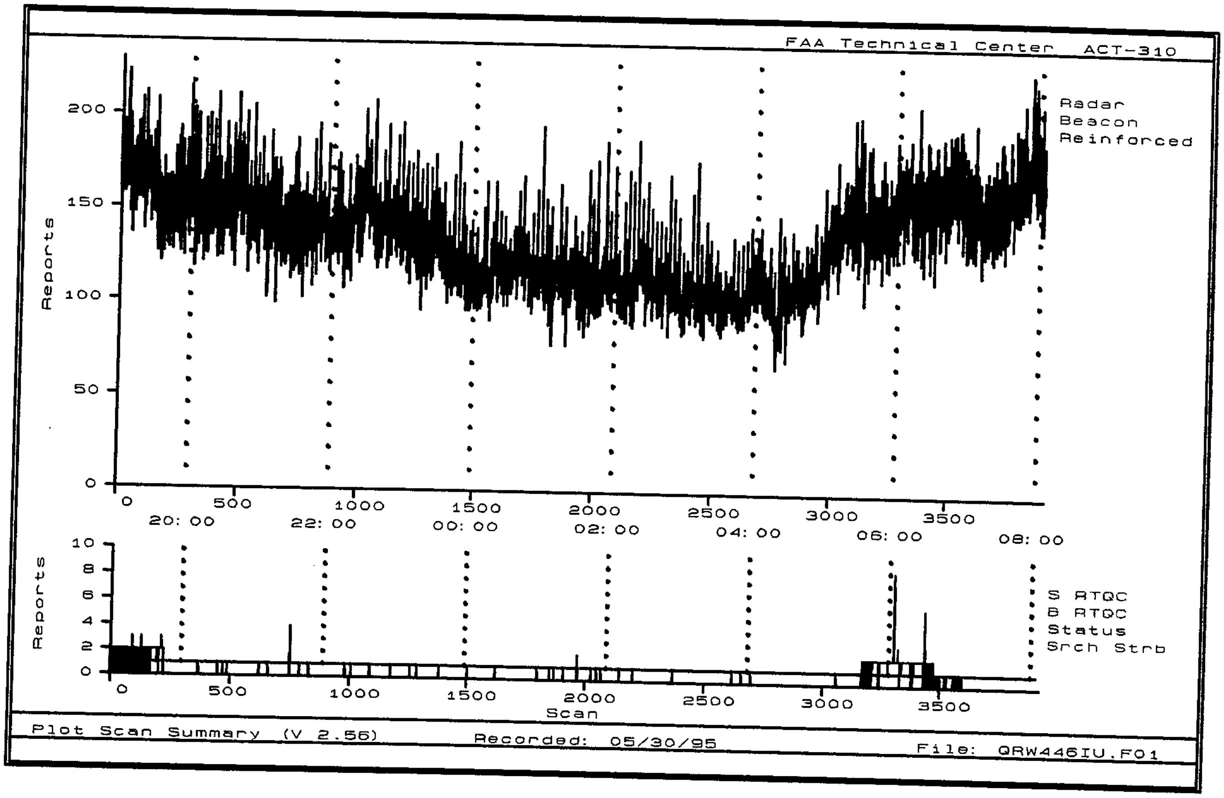

FIGURE 4.1.8-1 RUN 446 SEARCH REPORT COUNTS - FIRST FUNCTION OUTPUT

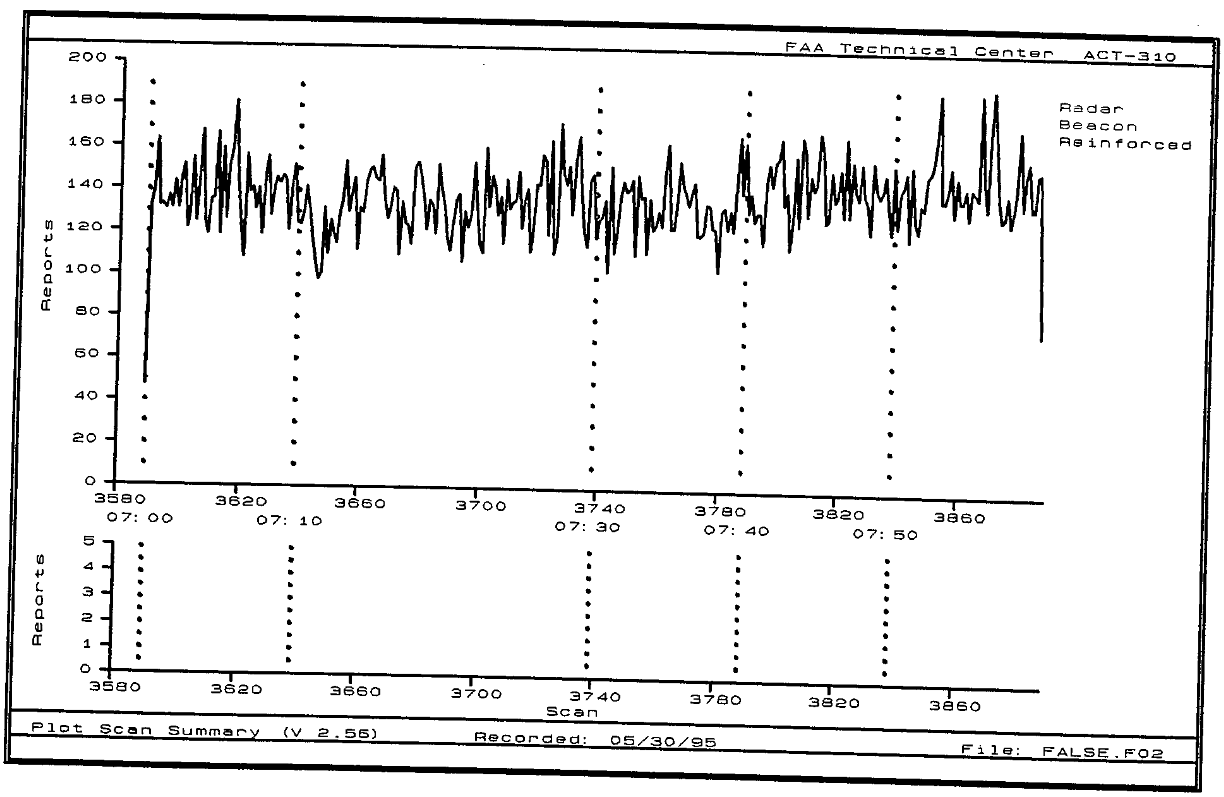

FIGURE 4.1.8-2 RUN 446 FALSE SEARCH COUNTS - FIRST FUNCTION OUTPUT

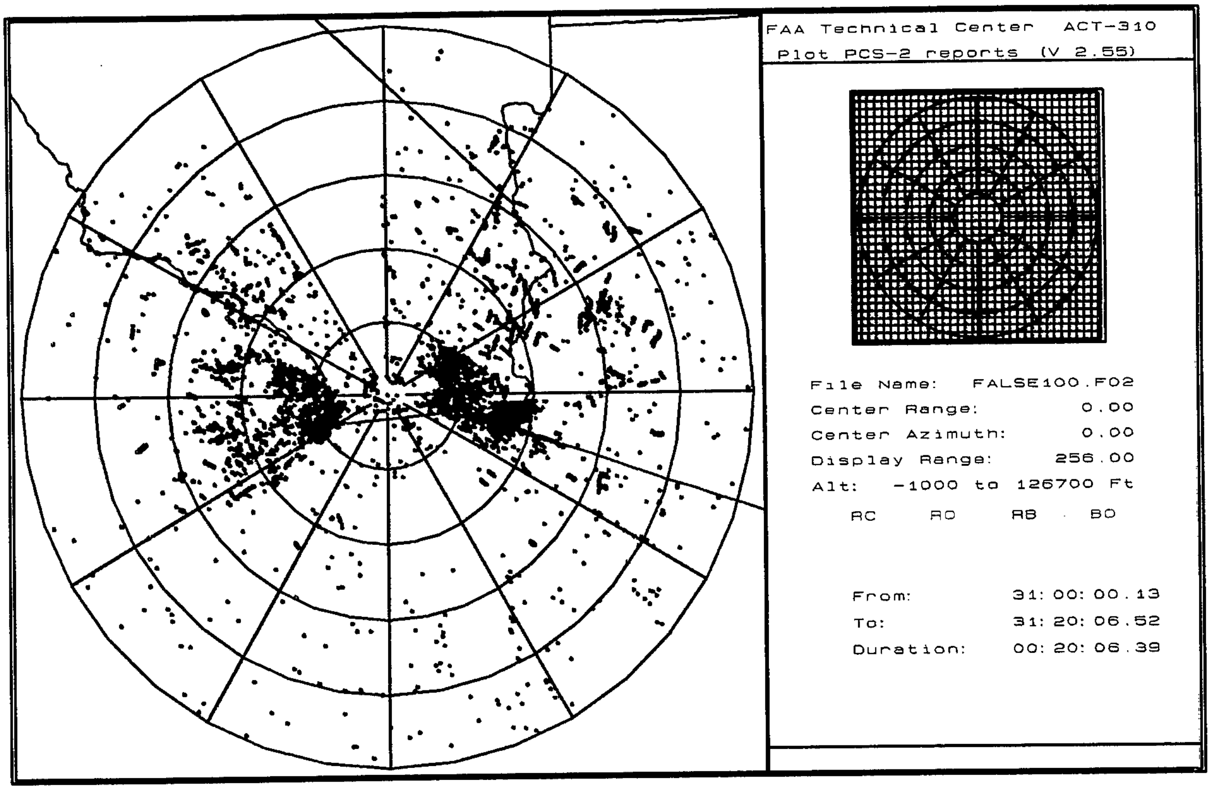

FIGURE 4.1.8-3 RUN 446 FALSE SEARCH REPORTS - 100 SCANS

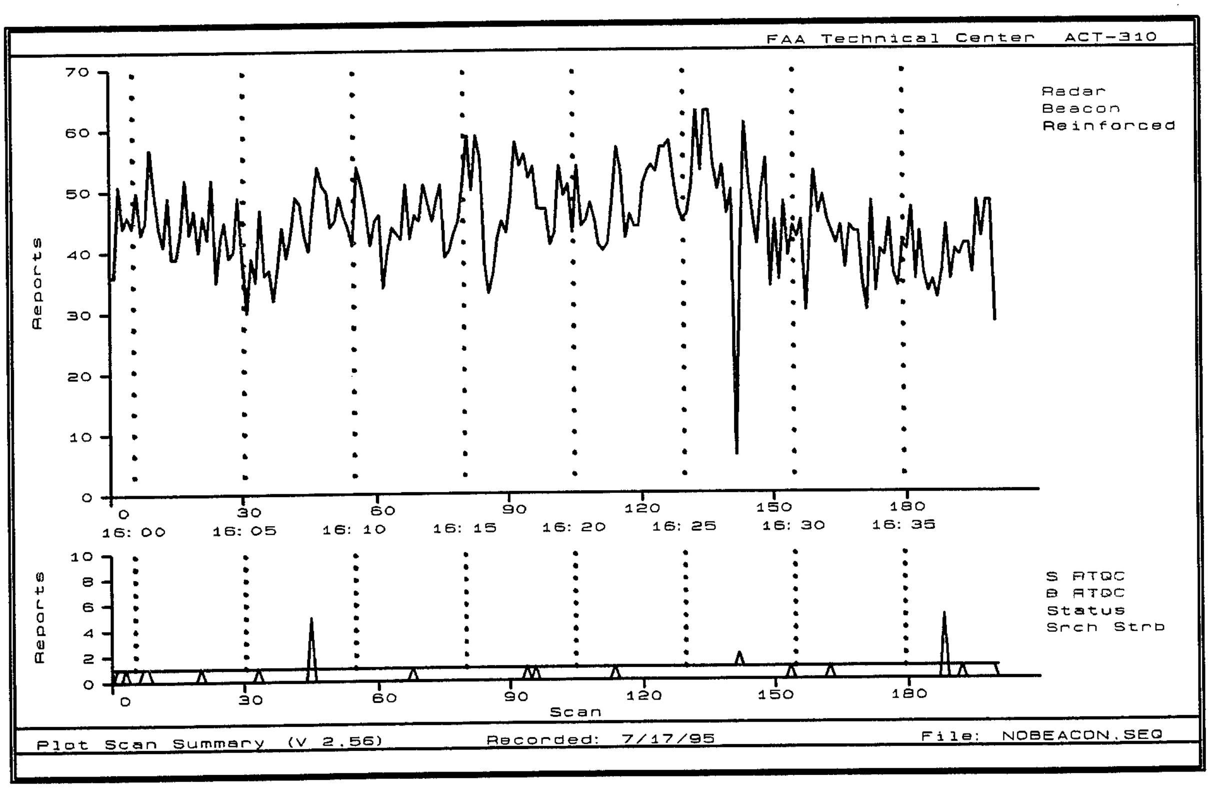

FIGURE 4.1.8-4 RUN 597 SEARCH REPORT COUNTS - SECOND FUNCTION OUTPUT

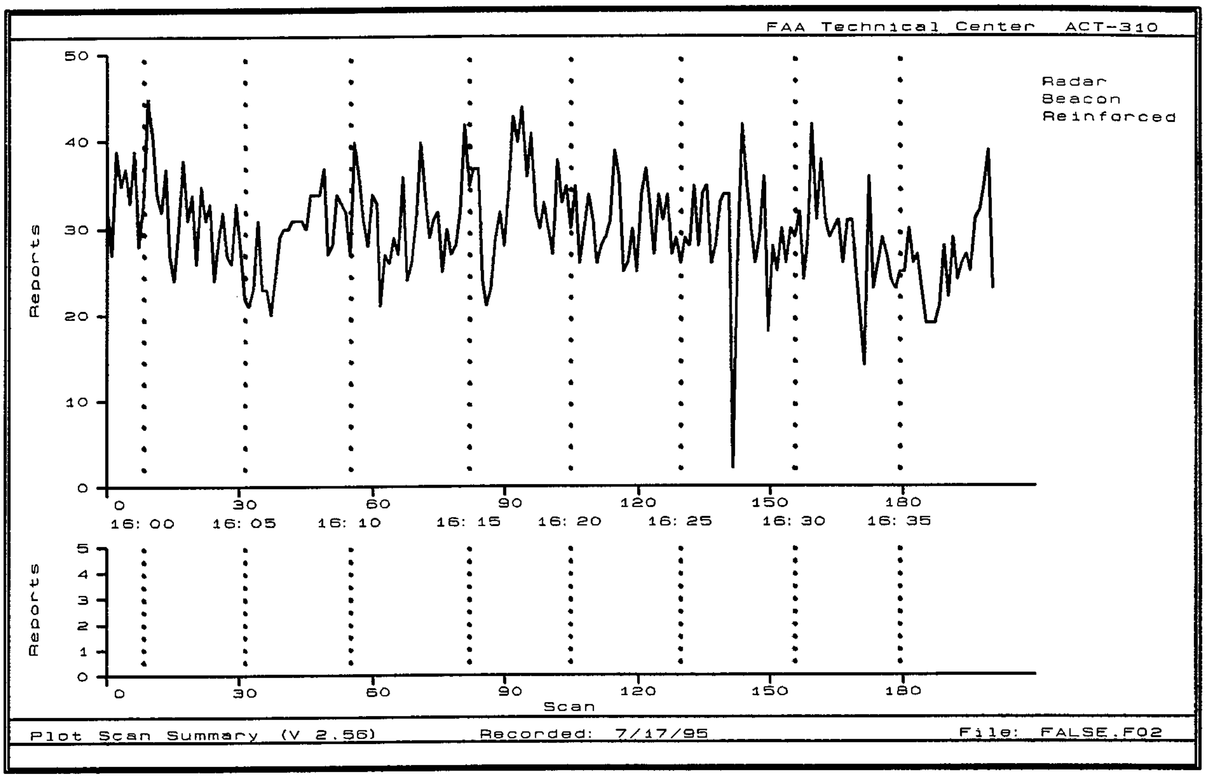

FIGURE 4.1.8-5 RUN597 FALSE SEARCH REPORTS - SECOND FUNCTION OUTPUT

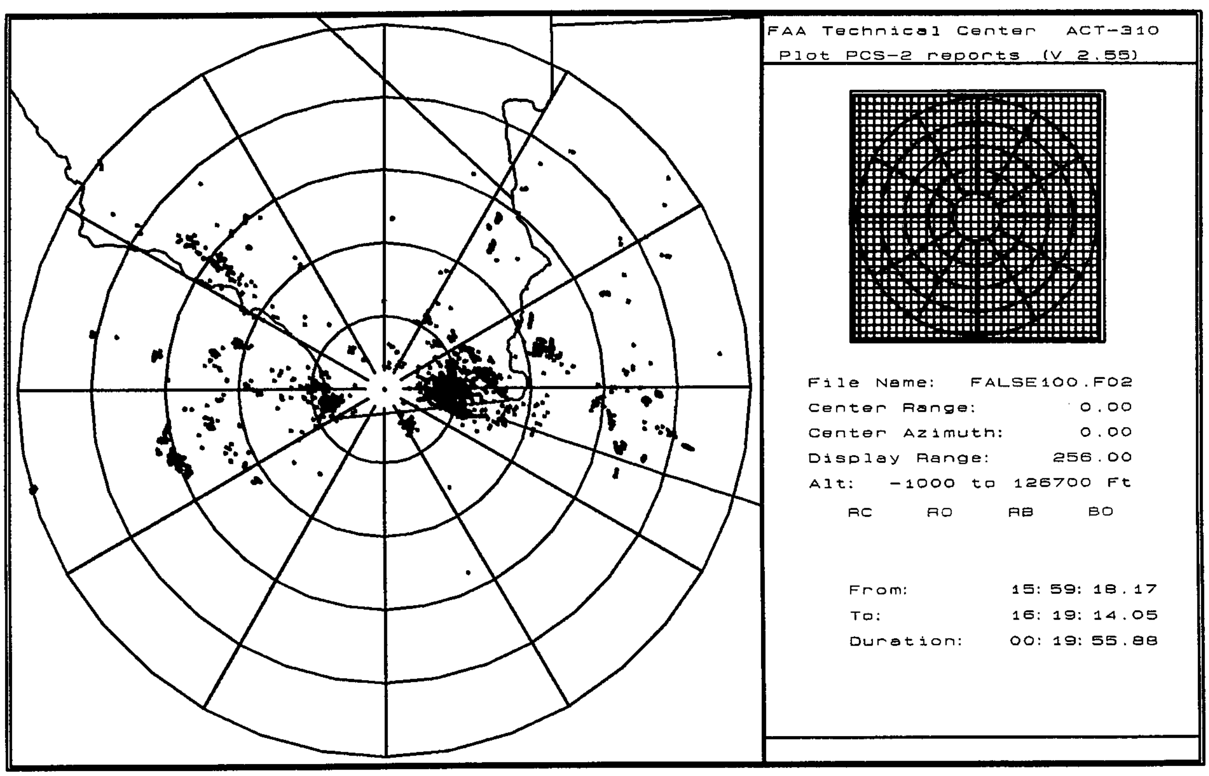

FIGURE 4.1.8-6 RUN597 FALSE SEARCH REPORTS - 100 SCANS

Controllers who observed primary false alarms (see section 4.2.1) indicated that the false targets (output from the second function) do not have an adverse effect on tracking a primary target, identifying a primary target, providing traffic advisories, or the overall control of air traffic.

Conclusions

a. The search false report rate measured at the output of the first function tracker was less than the specified 194 per scan.

b. As expected, the false search report rate measured at the output of the second function tracker was significantly reduced from the first function rate. However, the second function false report rate exceeded specification requirements. (i.e., greater than 10 percent of the first function false report rate).

c. The excess false search reports at the second function output were due to limited effectiveness of ARSR-4 geocensor and second function tracking filters in reducing the effects from strong clutter returns.

d. Controllers' responses to questionnaires indicate that the number of false search reports from the ARSR-4 (second function) do not have an adverse effect on the control of air traffic.

4.1.9 Surveillance Resolution.

Purpose

Verify that the radar resolution is sufficient to enable positive separation using published procedures.

Test Objectives

a. Verify that, between 5 and 200 nm, the ARSR-4 resolves with a 90-percent probability, two 10-square meter Swerling I targets separated by 2° in azimuth in the same range resolution cell and within 2,000 feet in altitude of each other.

b. Verify that, between 5 and 200 nm, the ARSR-4 resolves with a 90-percent probability, two 10-square meter Swerling I targets separated in range by 1/8 nm while in the same azimuth resolution cell and within 2,000 feet in altitude of each other.

c. Verify that, at 100 nm, the ARSR-4 resolves with 50-percent probability two 2.2-square meter RCS targets (T-38) separated by 1.5° in azimuth in the same range and doppler resolution cell and within 2000 feet in altitude of each other, while maintaining the specified azimuth accuracy on each target resolved.

Data Analysis

During the week of August 1, 1994, the 10-square meter azimuth and range resolution tests which previously failed both Phase I and II DT&E tests, were repeated at Mt. Laguna. Five azimuth resolution flights were conducted on August 2, 3, and 4. Three range resolution flights were then performed on August 5 and 6. Sufficient data for both the azimuth and range resolution tests were obtained through these flights.

The resolution tests were conducted using two Convair 580 (CV580) aircraft; N85790 and N92. The CV580 aircraft have a RCS section of approximately 21.9 square meters. Both Westinghouse Electric Corporation (WEC) and the government agreed to using these aircraft to verify resolution requirements.

The Convair aircraft flew in holding patterns between 85 and 110 nm from the radar at an azimuth of approximately 290°. For the azimuth tests, the aircraft flew in parallel holding patterns with a nominal lateral separation of 2.0° and 0 nm range separation. The height difference was less than 100 feet during all azimuth resolution flights. For the range resolution flights, the CV580 flew a tail chase configuration in the same holding pattern. The aircraft maintained a nominal range separation of 1/8 nm with 0° azimuth separation. The height separation was less than 300 feet throughout the range resolution tests.

Each CV580 was equipped with a Global Positioning System (GPS) receiver and a NIKE transponder to obtain true positional data. GPS data was recorded aboard each aircraft. During the azimuth resolution tests, NIKE data was recorded for aircraft N85790. NIKE data was obtained on aircraft N92 while conducting range resolution flights.

The GPS data was used to determine the actual position and separation of the two aircraft for measuring range and azimuth resolution. The GPS data from each aircraft was differentially corrected to obtain a specified positional accuracy of 15 meters. These differential corrections were obtained from a GPS differential station located at Mt. Laguna.

The NIKE system provides greater accuracy than the GPS and was employed to verify accuracy requirements for targets resolved. Since only one NIKE tracker was available, N85790 was tracked during azimuth resolution flights, while N92 was tracked during range resolution flights.

During the flights, data was collected using the ARSR-4 data extraction capability. The azimuth and range resolution data was reduced and analyzed using IRES. The two Convair test targets were tracked by the IRES alpha-beta tracker. The tracked target reports were then merged with GPS data based on time. Percent resolution was then computed based on the GPS reported separation and the existence of one (no resolution) or two (targets resolved) radar reports.

Results

Due to the unavailability of T-38 (2.2 square meter) test aircraft, only the 10-square meter flight tests were conducted during OT&E. Therefore, only the 10-square meter results will be discussed here. Results from phase I and phase II DT&E flight tests for the T-38 indicated that the ARSR-4 met the smaller target resolution requirement.

Azimuth resolution test results are shown in figure 4.1.9-1 and table 4.1.9-1. Percent resolution was calculated by dividing the number of times the radar resolved the closely spaced aircraft (i.e., two target reports output) by the number of opportunities. The separation data samples were grouped into 1 ACP wide azimuth bins. The resolution was calculated for samples in each bin.

There are three plots shown in figure 4.1.9-1. The plot in the left portion of the figure shows the resolution percentage measured at each azimuth separation of the two aircraft. The plot in the upper right hand portion of the figure shows the azimuth separation distribution of the data samples. The plot in the lower right hand portion of the figure shows the error between the radar measured separation and the GPS measured separation.

The data samples used for azimuth resolution analysis were taken from cases when the targets were separated in range by less than or equal to 28/256 nm (targets in same range cell) and a height separation less than 2000 feet.

Figure 4.1.9-1 shows that the resolution exceeds 90 percent at a separation of 21 ACPs. However, at the specified separation of 23 ACPs, the resolution drops below 90 percent. Table 4.1.9-1 shows that 83 percent resolution is achieved at the required 23 ACP separation. The number of data samples exceeds 100 for separations between 19 and 26 ACPs, providing a high confidence in the measured resolution value. These test results indicate that the 90-percent resolution requirement is not being achieved by the current ARSR-4 system.

To smooth the azimuth resolution data due to inherent radar inaccuracies, analysis was also conducted with a 2-ACP azimuth bin size. Figure 4.1.9-2 and table 4.1.9-2 contain the results for a 2-ACP azimuth bin. The 90-percent resolution requirement is never achieved with data smoothed for a 2-ACP bin size. At the specified 2.0° separation (23 ACPs), a linear interpolation between the 22 and 24 ACP separations in table 4.1.9-2 indicates a resolution of 88 percent.

The range resolution test results for a range bin size of 1/256 nm are shown in figure 4.1.9-3 and table 4.1.9-3. Data samples are based on the measured range separation, an azimuth separation of less than 10 ACPs and a height separation of less than 2000 feet. Figure 4.1.9-3 shows that 90-percent resolution is not achieved until a range separation of 34/256 nm, which is greater than the 1/8 nm (32/256 nm) requirement. Ninety-percent resolution is not maintained until the targets are separated by 42/256 nm.

Table 4.1.9-3 shows that the range resolution at the required 1/8 nm is 88 percent. The number of samples for the 32/256 nm separation requirement is 43 indicating good confidence in the measured resolution percentage. This data shows that the range resolution requirement is not met by the current ARSR-4.

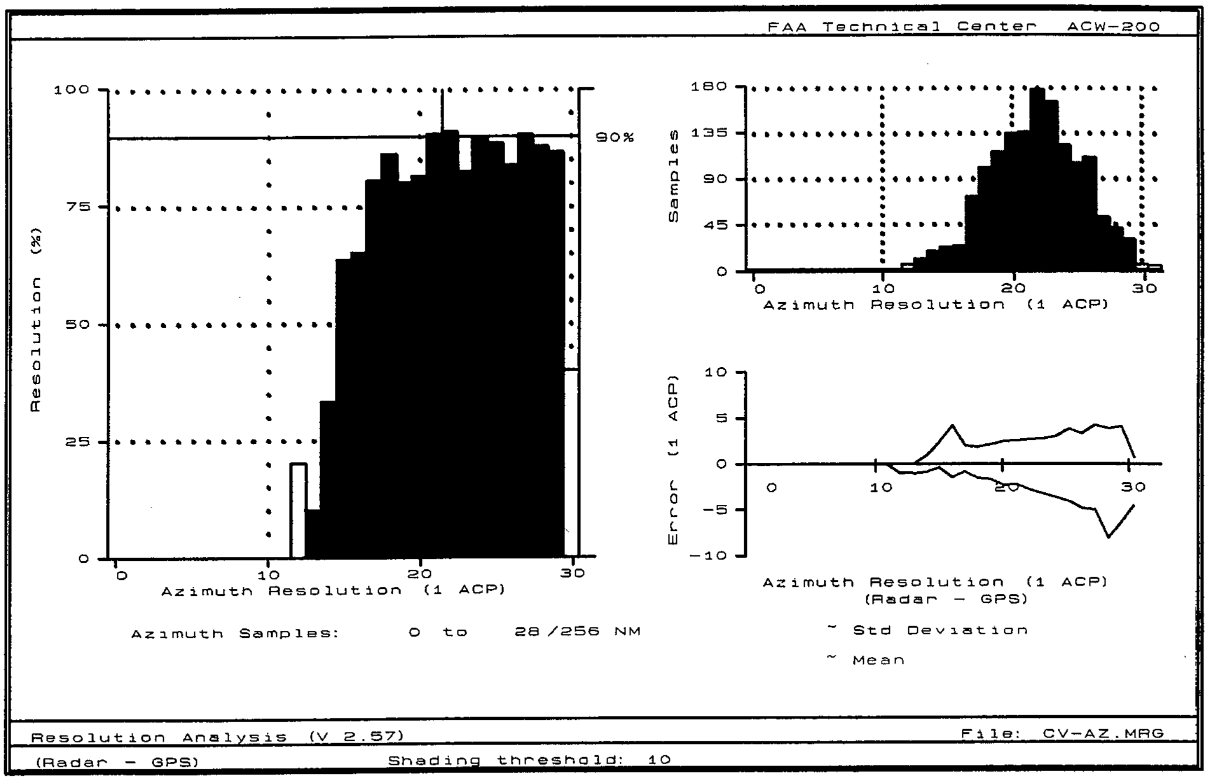

FIGURE 4.1.9-1 CV580 AZIMUTH RESOLUTION: 1 ACP BIN SIZE

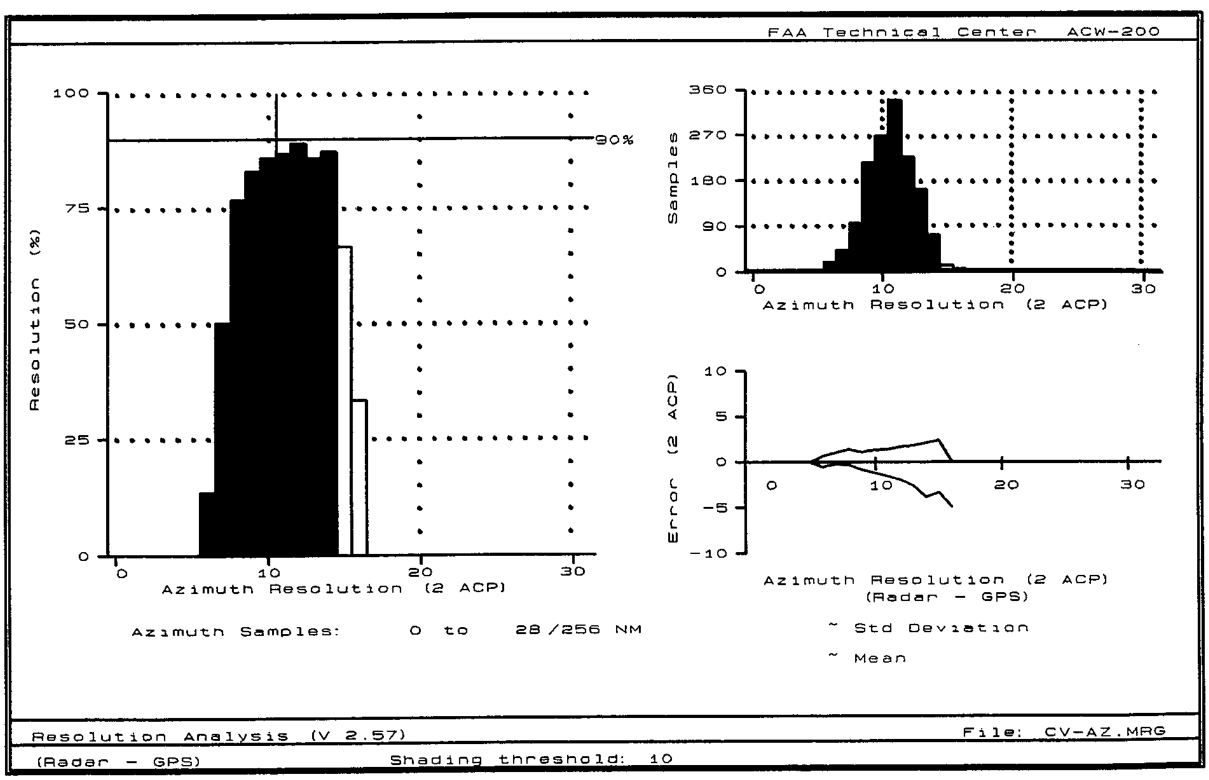

FIGURE 4.1.9-2 CV580 AZIMUTH RESOLUTION: 2 ACP BIN SIZE

TABLE 4.1.9-1. CV580 AZIMUTH RESOLUTION 1 ACP BIN SIZE

Delta Azimuth (ACP)	Hits	Scans	Resolution %	Mean	STD
12	1	5	20	-1.000	0.000
13	1	10	10	-1.000	0.000
14	6	18	33	-0.833	0.983
15	14	22	64	-0.357	2.437
16	15	23	65	-1.400	4.339
17	58	72	81	-0.741	2.082
18	87	101	86	-1.448	1.951
19	93	116	80	-1.581	2.267
20	110	135	81	-2.236	2.616
21	123	136	90	-2.154	2.652
22	162	178	91	-2.747	2.836
23	137	166	83	-3.161	2.896
24	110	123	89	-3.609	3.154
25	93	105	89	-4.000	3.923
26	93	111	84	-4.849	3.451
27	47	52	90	-4.936	4.346
28	36	41	88	-8.194	4.048
29	26	30	87	-6.423	4.254
30	2	5	40	-4.500	0.707
31	4	4	100	-8.250	5.852
32	1	2	50	-10.000	0.000

TABLE 4.1.9-2. CV580 AZIMUTH RESOLUTION 2 ACP BIN SIZE

Delta Azimuth (2 ACPS)	Hits	Scans	Resolution %	Mean	STD
6	2	15	13	-0.500	0.707
7	20	40	50	-0.200	1.105
8	73	95	77	-0.288	1.419
9	180	217	83	-0.772	1.138
10	233	271	86	-1.086	1.346
11	299	344	87	-1.488	1.450
12	203	228	89	-1.916	1.763
13	140	163	86	-2.529	1.898
14	62	71	87	-3.806	2.194
15	6	9	67	-3.333	2.422
16	1	3	33	-5.000	0.000

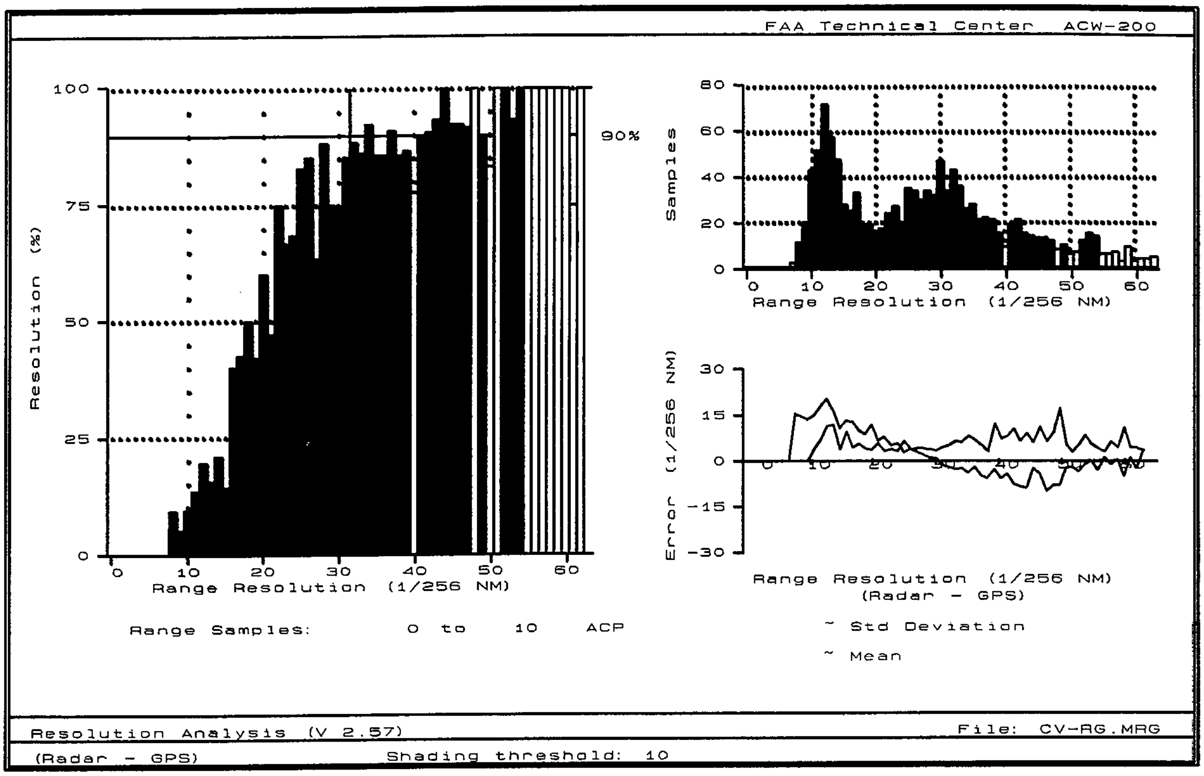

FIGURE 4.1.9-3 CV580 RANGE RESOLUTION: 1/256 NM BIN SIZE

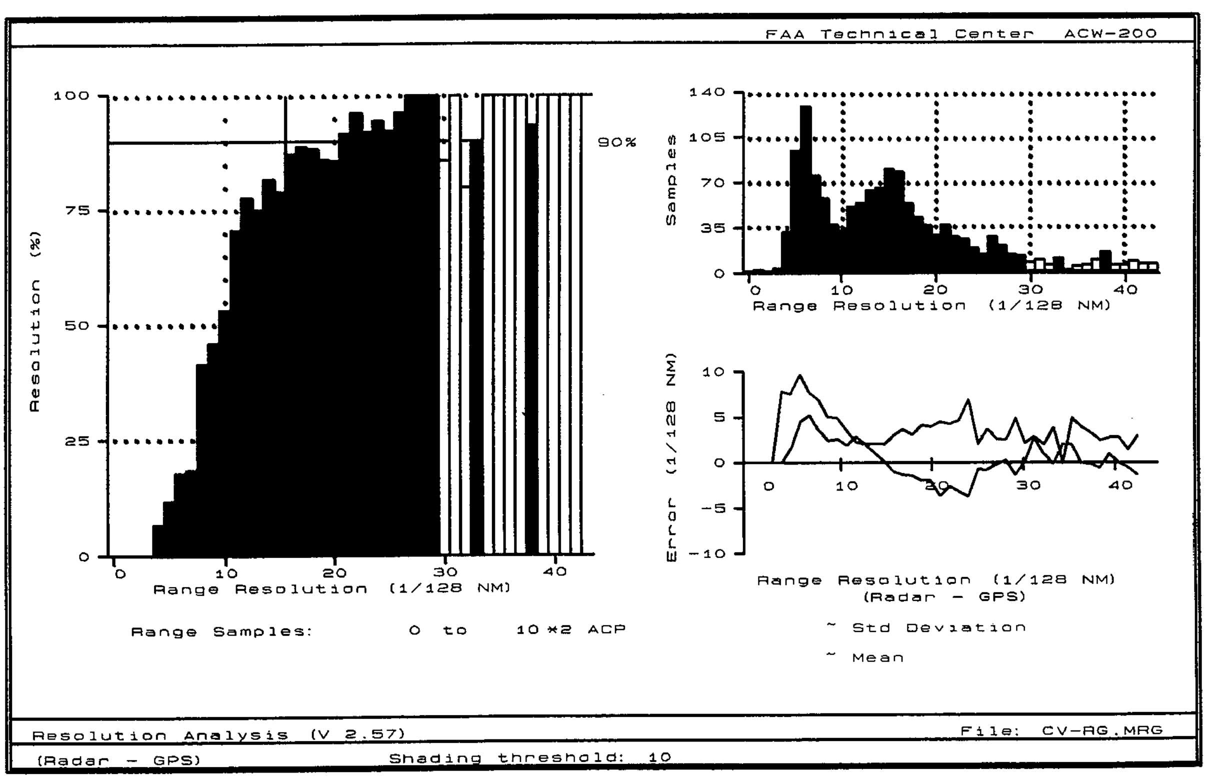

FIGURE 4.1.9-4 CV580 RANGE RESOLUTION: 1/128 NM BIN SIZE

TABLE 4.1.9-3. CV580 RANGE RESOLUTION 1/256 NM BIN SIZE

Delta Range (1/256 NM)	Hits	Scans	Resolution %	Mean	STD
8	1	11	9	16.000	0.000
9	1	20	5	15.000	0.000
10	4	43	9	14.000	0.000
11	7	52	13	15.286	3.904
12	14	72	19	18.286	7.141
13	9	58	16	20.778	11.851
14	10	48	21	17.200	12.191
15	4	28	14	11.000	4.000
16	10	25	40	13.600	10.013
17	14	33	42	13.286	4.631
18	9	18	50	10.444	5.812
19	8	19	42	9.000	4.276
20	9	15	60	12.000	4.000
21	8	17	47	7.000	6.047
22	18	24	75	8.222	3.422
23	18	27	67	5.444	4.090
24	13	19	68	6.154	3.508
25	29	35	83	3.138	6.632
26	29	34	85	4.069	4.088
27	19	30	63	3.316	4.282
28	30	34	88	2.400	4.407
29	24	32	75	1.333	4.072
30	35	47	74	1.086	3.768
31	29	34	85	-1.207	4.731
32	38	43	88	-1.895	5.402
33	31	36	86	-2.548	6.668
34	24	26	92	-2.333	6.452
35	24	28	86	-3.667	8.478
36	18	21	86	-1.778	7.158
37	20	22	91	-4.600	5.491
38	18	21	86	-5.556	3.329
39	13	15	87	-2.692	12.486
40	7	9	78	-5.714	7.610
41	17	19	89	-4.294	8.513
42	19	21	90	-7.474	10.684
43	14	15	93	-8.143	6.735
44	14	14	100	-8.571	9.263
45	12	13	92	-2.333	6.228
46	12	13	92	-4.000	11.378
47	11	12	92	-9.909	6.472
48	8	8	100	-8.000	9.562
49	9	10	90	-8.111	17.638
50	5	6	83	-2.000	5.657
51	7	7	100	-1.857	3.024
52	12	12	100	-3.333	5.348
53	14	15	93	-1.000	8.735
54	14	14	100	0.286	5.594
55	6	6	100	-3.000	4.382
56	6	6	100	1.333	3.266
57	7	7	100	-1.000	6.532
58	3	3	100	0.667	4.619
59	9	9	100	-4.778	11.155
60	3	3	100	1.333	4.619

To smooth the data points, the range bin was adjusted for 1/128 nm. The results of range resolution analysis with a 1/128 nm range bin are shown in figure 4.1.9-4 and table 4.1.9-4. The 90-percent resolution requirement is not achieved or maintained until the targets are separated by 21/128 nm, which is greater than the 1/8 nm (16/128 nm) requirement. Table 4.1.9-4 shows 87 percent resolution at the required 16/128 nm separation. In addition the sample size at this separation is 79, providing a high confidence in the measured value. This data also shows that the ARSR-4 falls short of meeting the 90 percent resolution requirement with a 1/8 nm (16/128 nm) range separation.

TABLE 4.1.9-4. CV580 RANGE RESOLUTION: 1/128 NM BIN SIZE

Delta Range (1/128NM)	Hits	Scans	Resolution %	Mean	STD
5	11	95	12	7.727	1.618
6	23	130	18	9.826	4.589
7	14	76	18	7.857	5.304
8	24	58	41	7.000	3.587
9	17	37	46	5.118	2.497
10	17	32	53	5.059	2.657
11	36	51	71	3.667	1.912
12	42	54	78	2.381	2.938
13	48	64	75	2.083	2.061
14	54	66	82	1.185	2.111
15	64	81	79	0.250	2.123
16	69	79	87	-0.870	2.980
17	48	54	89	-1.250	3.727
18	38	43	88	-1.368	3.157
19	31	36	86	-1.968	4.254
20	24	28	86	-2.000	4.086
21	33	36	92	-3.667	4.546
22	26	27	96	-2.615	4.337
23	23	25	92	-3.174	4.745
24	17	18	94	-3.765	6.996
25	12	13	92	-0.667	2.060
26	26	27	96	-0.769	3.713
27	20	20	100	-0.200	2.628
28	13	13	100	0.308	2.562
29	12	12	100	-1.333	4.960
30	6	7	86	0.000	2.191
31	9	9	100	2.778	2.906
32	4	5	80	1.000	2.000
33	9	10	90	-0.111	3.887
34	1	1	100	2.000	0.000
35	4	4	100	2.000	5.033
36	5	5	100	0.000	4.000
37	9	9	100	-0.111	3.333
38	14	15	93	-0.571	2.533
39	5	5	100	1.000	2.828
40	5	5	100	0.000	2.828
41	8	8	100	-0.500	1.414
42	6	6	100	-1.333	3.011

Another anomaly was observed in the resolution data recorded for these flights. An increase in the allowable range separation, for targets which are included in the azimuth resolution analysis, resulted in a significant reduction (approximately 25 percent) in resolution. This indicates that when two targets are separated in azimuth by approximately 2° and also have a range separation of greater than 1/8 nm, the targets are not being resolved.

Figure 4.1.9-5 and table 4.1.9-5 show the results of the range resolution analysis performed on the azimuth resolution flight data. The azimuth samples were restricted to greater than 22 ACPs (i.e., greater than the required azimuth resolution separation). The data shows a hole in the range resolution when the targets are separated by more than 32/256 nm. The resolution percentage again crosses the 90 percent required level at 54/256 nm. Therefore, when targets are separated by greater than the required resolution distance, the ARSR-4 fails to resolve the targets.

Conclusions

Phase I and Phase II DT&E test results indicated that the ARSR-4 met the 2.2 square meter azimuth resolution requirement (50 percent resolution with 1.5° separation). Note that this is a less stringent resolution requirement than for the 10 square meter targets.

The ARSR-4 does not meet specified and operational azimuth/range resolution requirements for the CV-580. The measured results showed 88 percent resolution beyond the specified separation versus the required 90-percent resolution. This is a minor problem and will not be noticed by the end user. The use of aircraft with a larger RCS (21.9 square meters) than the specified 10 square meters RCS may contribute to the lesser measured resolution.

Results show that when the two CV-580 test aircraft were separated by greater than 2° and 1/8 nm, the measured resolution percentage did not meet the 90-percent requirement. The resolution "hole" extended to 54/256 nm (nearly 1/4 nm) separation before 90-percent resolution was again achieved. These results point to a problem in the ARSR-4 resolution algorithms.

Recommendations

The operational significance of the range resolution hole between 1/8 nm and 1/4 nm should be evaluated by AT personnel. If the hole is deemed to be an operational problem, then corrections should be made to the ARSR-4 resolution algorithms and those fixes should be retested.

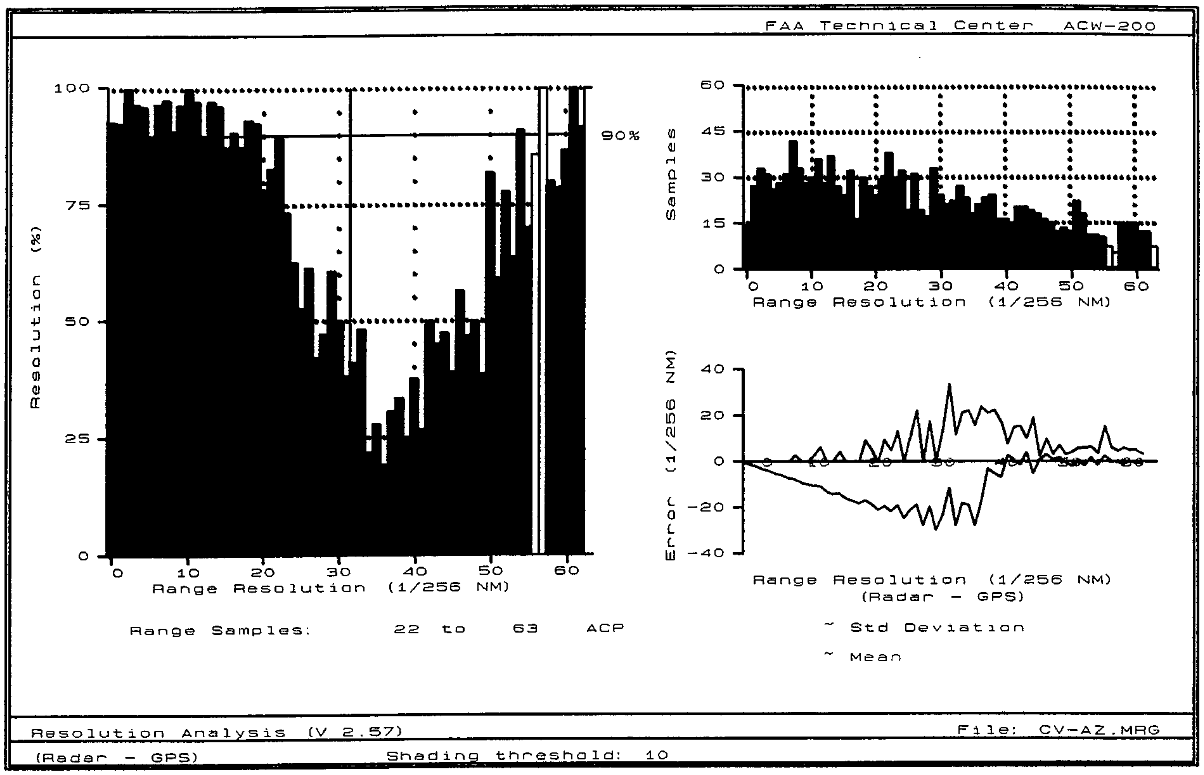

FIGURE 4.1.9-5 CV580 RANGE RESOLUTION - AZIMUTH SAMPLES (22-63 ACPs)

TABLE 4.1.9-5. CV580 RANGE RESOLUTION - AZIMUTH SAMPLES (22-63 ACPs)

Delta Range (1/256 NM)	Hits	Scans	Resolution %	Mean	STD
7	41	42	98	-7.000	0.000
8	30	33	91	-7.467	2.921
9	27	28	96	-9.000	0.000
10	30	30	100	-10.000	0.000
11	35	36	97	-10.543	2.704
12	25	28	89	-10.720	6.400
13	36	37	97	-13.000	0.000
14	26	27	96	-14.000	0.000
15	21	24	88	-14.048	4.364
16	29	32	91	-16.000	0.000
17	14	16	88	-17.000	0.000
18	28	30	93	-18.000	0.000
19	25	27	93	-17.080	9.600
20	18	23	78	-18.667	5.657
21	24	29	83	-21.000	0.000
22	34	38	89	-19.647	9.754
23	22	30	73	-21.909	5.117
24	20	32	63	-19.200	13.586
25	10	19	53	-25.000	0.000
26	19	31	61	-21.368	11.413
27	8	19	42	-19.000	22.627
28	8	17	47	-28.000	0.000
29	20	33	61	-19.800	17.656
30	12	24	50	-30.000	0.000
31	8	21	38	-23.000	14.813
32	9	22	41	-11.556	34.202
33	13	27	48	-28.077	12.017
34	5	23	22	-18.000	21.909
35	5	18	28	-19.000	22.627
36	4	21	19	-28.000	16.000
37	7	23	33	-17.571	24.378
38	8	24	33	-3.000	21.778
39	4	16	25	-5.000	22.978
40	6	16	38	-6.667	17.829
41	4	15	27	3.000	8.000
42	10	20	50	1.200	15.640
43	9	20	45	-1.222	15.889
44	9	19	47	4.000	10.583
45	7	18	39	-5.000	19.596
46	9	16	56	1.111	2.667
47	7	15	47	3.286	10.029
48	6	12	50	1.333	3.266
49	5	13	38	2.200	7.155
50	9	11	82	-0.222	3.528
51	13	22	59	-1.769	4.438
52	14	18	78	0.000	6.076
53	7	11	64	-1.571	6.294
54	10	11	91	2.000	6.532
55	7	10	70	-1.286	3.904
56	6	7	86	2.667	15.731
57	5	5	100	0.600	6.693
58	12	15	80	0.000	4.973
59	11	14	79	-0.818	6.290
60	13	15	87	0.308	5.282

4.1.10 Surveillance Accuracy.

Purpose
The purpose of this test was to determine if the ARSR-4's positional accuracy is sufficient for operational use.

Test Objectives

a. Verify that the ARSR-4 provides single scan range surveillance information which is accurate to 1/16 nm (rms values including all bias and jitter errors) within the entire detection envelope.

b. Verify that the ARSR-4 provides single scan azimuth surveillance information which is accurate to 0.176° (rms values including all bias and jitter errors), within the entire detection envelope.

c. Verify that the beacon target processor reports at least 98 percent of all detected stationary targets at their correct slant ranges, plus or minus 1/32 nm. Verify that at least 95 percent of all moving targets with radial velocities of 700 knots or less are reported at their correct (average) slant range, plus or minus 1/16 nm.

d. Verify that the beacon target processor (BTP) reports at least 80 percent of all detected stationary targets at their correct azimuths, plus or minus 0.176°, when the associated beacon radar is interrogating at 10 times per degree of the antenna's rotation.

Test Description
Azimuth resolution flight test data was analyzed to produce the ARSR-4 accuracy results. The flight test scenarios are described in the Surveillance Resolution section of this report.

Each aircraft was equipped with a GPS receiver. A GPS ground station was located at Mt. Laguna during the tests. The differentially corrected GPS data (accurate to within 15 meters) was used as the primary source of positional truth in the accuracy analysis.

Data Analysis
Data was collected from the ARSR-4 data extraction subsystem during the test. The data was converted to IRES format where it was tracked by the IRES alpha-beta tracker. The tracked reports were then merged with GPS data based on time. The GPS reported positions were used as truth in comparison with the ARSR-4 reported positions.

Results
Search range accuracy results are shown in figure 4.1.10-1. The figure shows that the mean range difference between the ARSR-4 and GPS was -8.1/256 nm with a standard deviation of 9.5/256 nm. The results from these tests reveal an approximate 1/32 nm range bias in the ARSR-4 reported range.

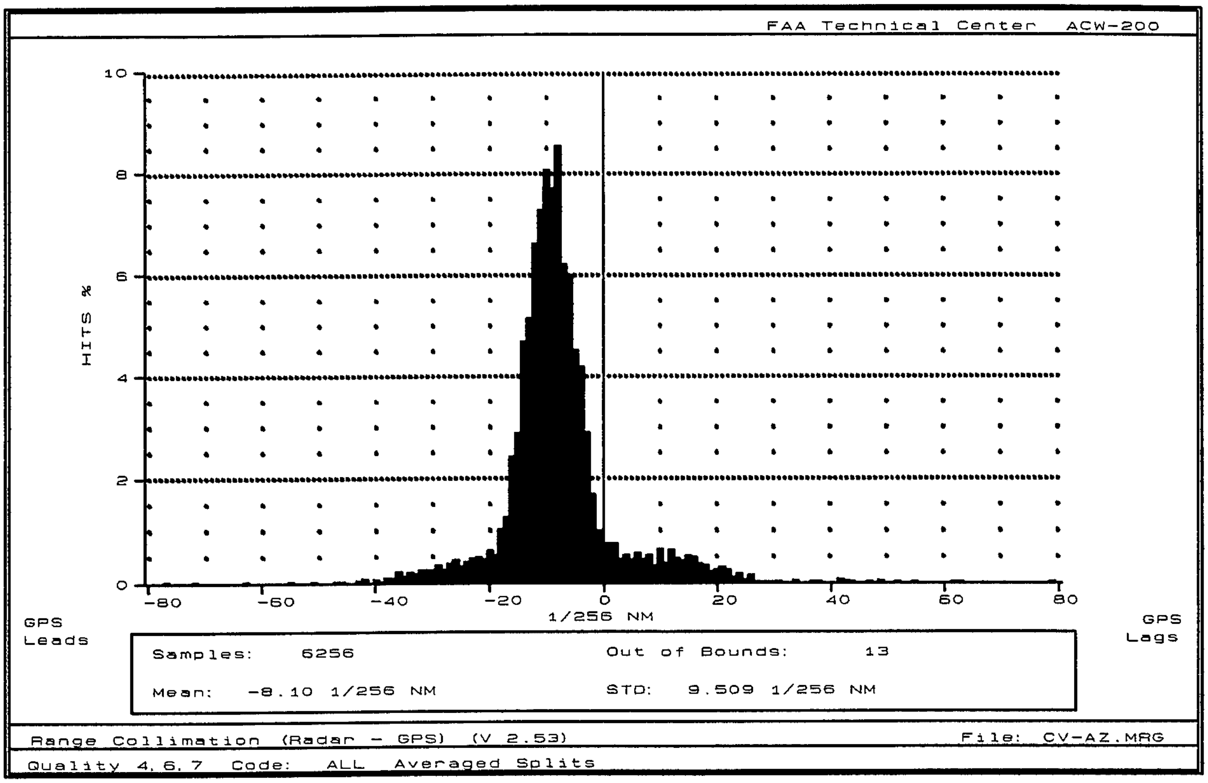

FIGURE 4.1.10-1 ARSR-4 SEARCH RANGE ACCURACY VS GPS - BOTH AIRCRAFT

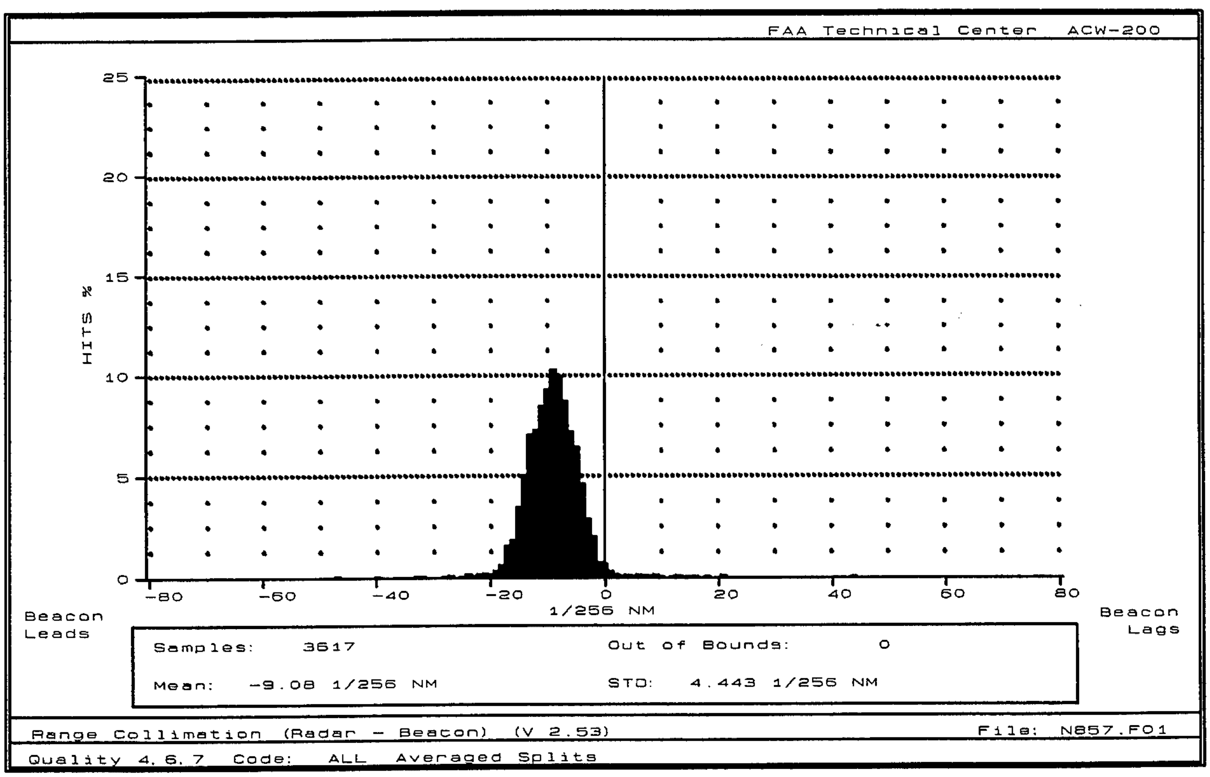

FIGURE 4.1.10-2 SEARCH RANGE ACCURACY VS BEACON - N857 AIRCRAFT

The search range bias is further verified through a collimation of each aircraft (N857 and N92) reported search range with the reported beacon range. Figures 4.1.10-2 and 4.1.10-3 show the radar-beacon collimation for each test aircraft. The results are consistent with the results in figure 4.1.10-1, showing that the radar is biased in range.

With the added bias, the ARSR-4 search range accuracy was measured at 17.6/256 nm. Although this number exceeds the 1/16 nm requirement, the error in GPS range reporting must be considered. The differentially corrected GPS data was specified accurate to within 15 meters (2/256 nm). Therefore, the difference between the measured search range accuracy and the specified accuracy falls within the error of the GPS system. The ARSR-4 meets the specified search range accuracy requirement (even with the 1/32 nm range bias).

Figure 4.1.10-4 shows the search azimuth accuracy results for each flight. The figure shows a mean azimuthal difference of -.1 ACP (-.009°) with a standard deviation of .163 ACP (.014°). The measured search azimuth accuracy is well within the 0.176° requirement.

Figure 4.1.10-5 shows the beacon range accuracy results for both aircraft. The figure shows two accuracy distributions. Further investigation showed that each distribution is contributed from one of the two test aircraft. A small range error (approximately 1/32 nm) introduced by the transponder on the N92 aircraft is suspected. The data for N857 was filtered and the collimation shown in figure 4.1.10-6. The figure shows a mean range difference of 0.09/256 nm with a standard deviation of 3.055/256 nm. The measured beacon range accuracy meets specified requirements.

Beacon azimuth accuracy results are shown in figure 4.1.10-7. The figure shows a mean azimuthal difference of -.118 ACP (.010°) with a standard deviation of .198 ACP (.017°). The measured beacon azimuth accuracy meets specified requirements.

Conclusions

The ARSR-4 meets the specified range and azimuth accuracy requirements for both search and beacon processing.

There is an approximate 1/32 nm range bias between the ARSR-4 reported search range and the range as reported from the more accurate GPS position.

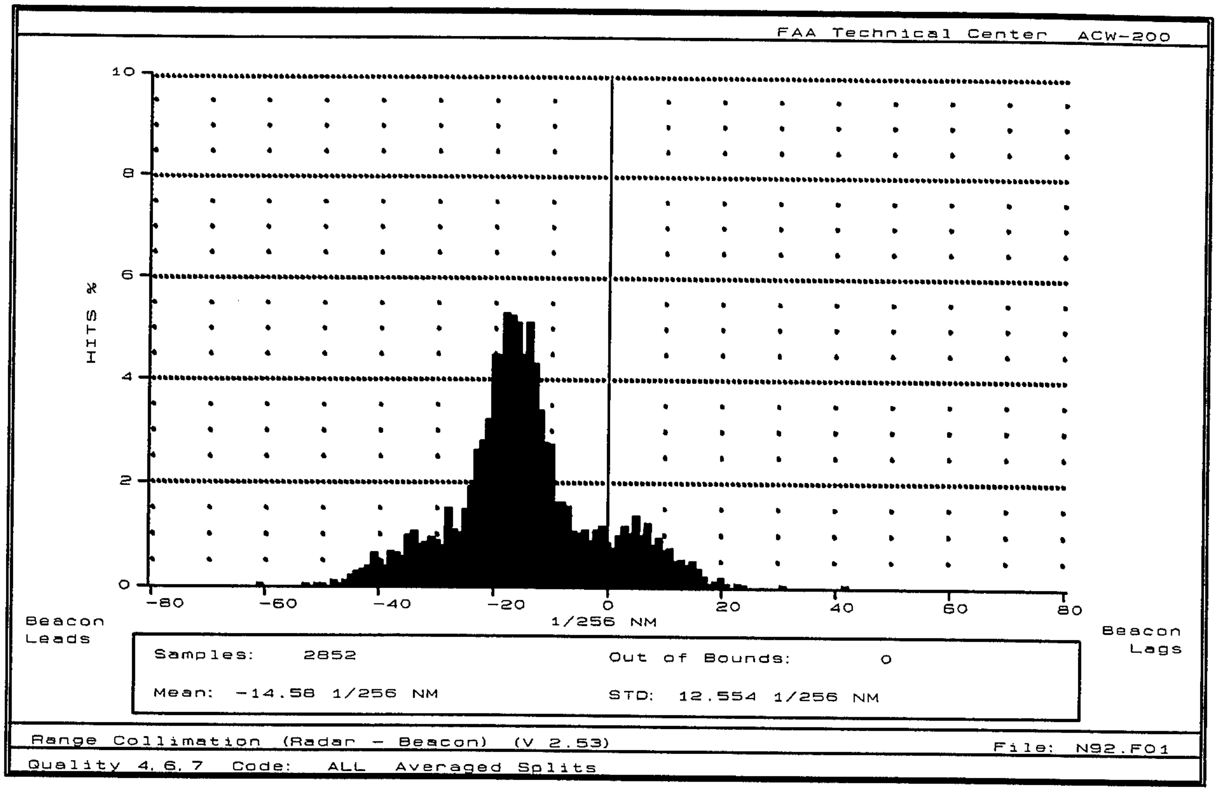

FIGURE 4.1.10-3 SEARCH RANGE ACCURACY VS BEACON - N92 AIRCRAFT

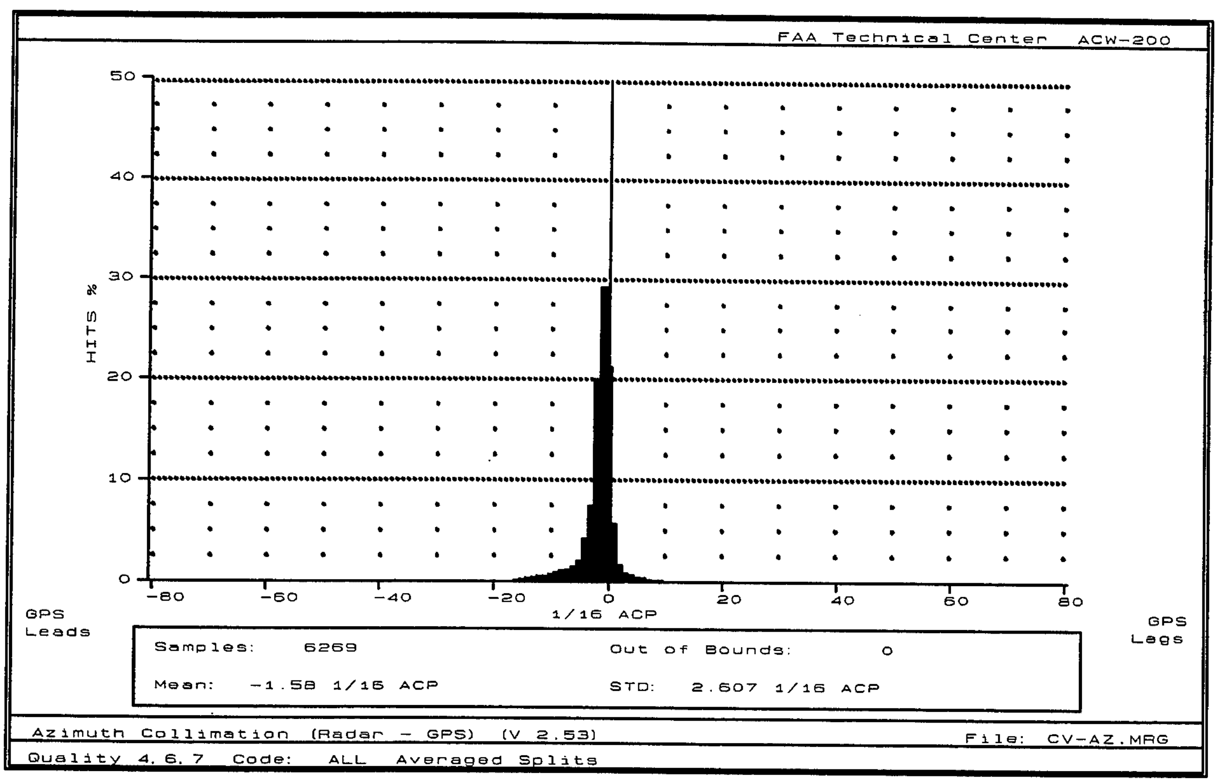

FIGURE 4.1.10-4 SEARCH AZIMUTH ACCURACY VS GPS - BOTH AIRCRAFT

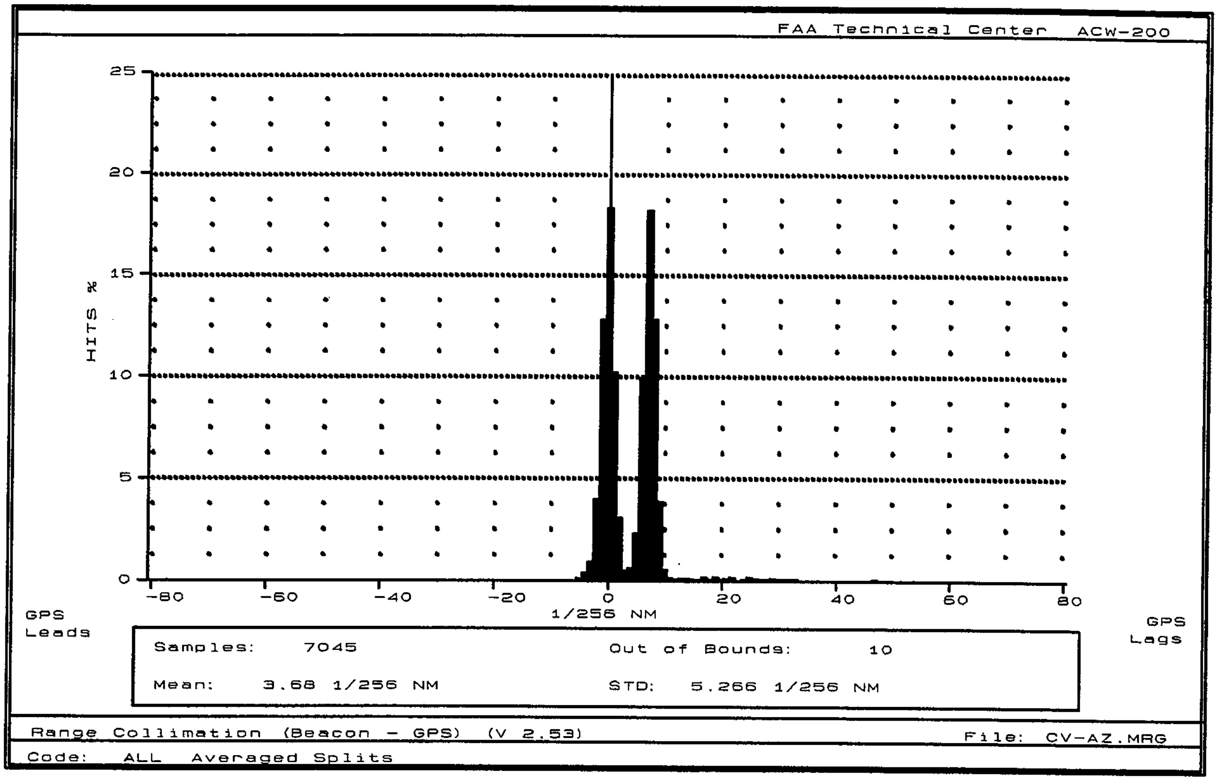

FIGURE 4.1.10-5 BEACON RANGE ACCURACY VS GPS - BOTH AIRCRAFT

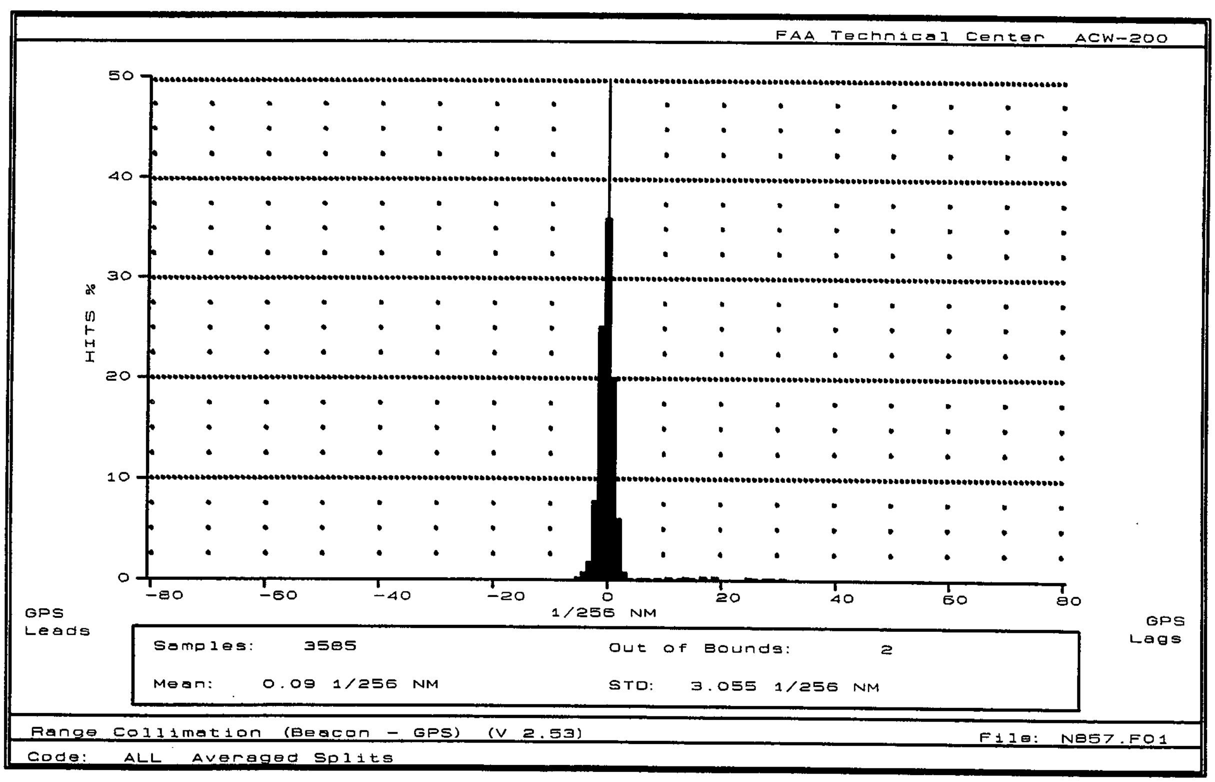

FIGURE 4.1.10-6 BEACON RANGE ACCURACY VS GPS - N857 AIRCRAFT

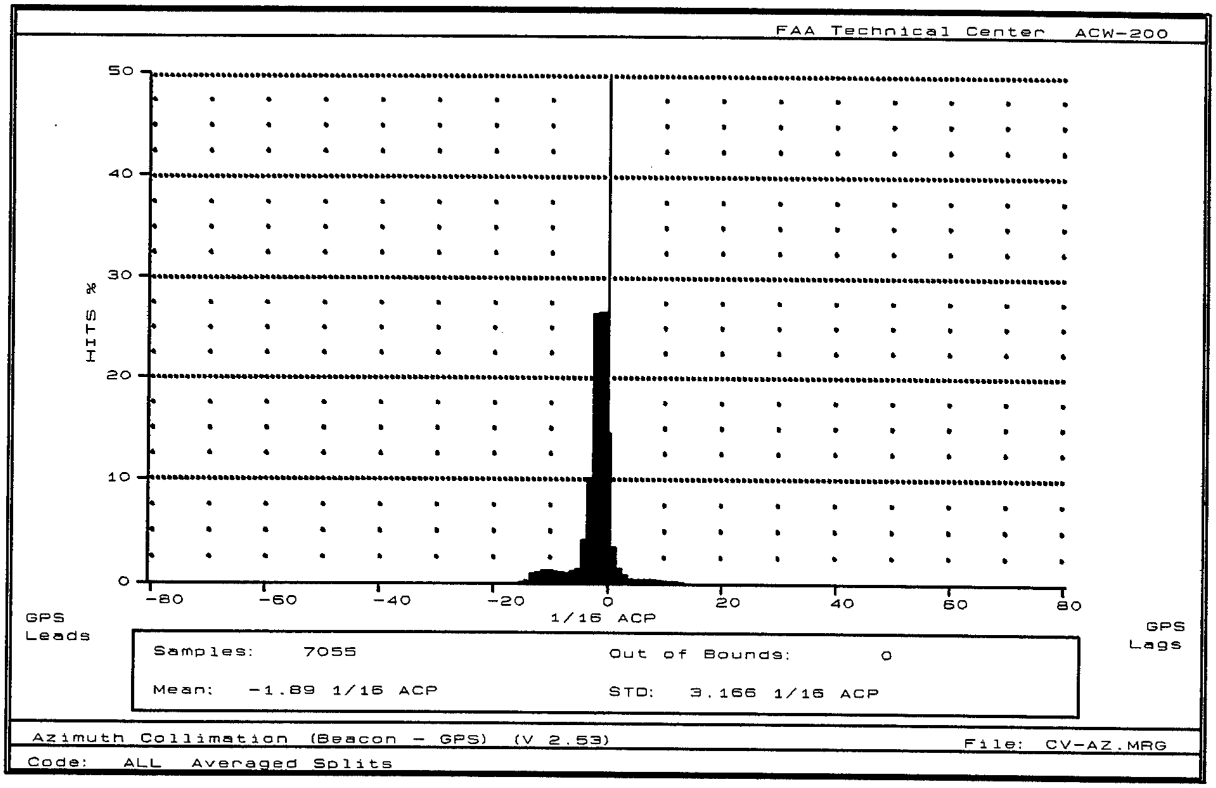

FIGURE 4.1.10-7 BEACON AZIMUTH ACCURACY VS. GPS

4.1.11 Beacon Target Processor Performance.

The tests described in this section were designed to evaluate the effectiveness of the ARSR-4 BTP, interfaced with an ATCBI-5, in detecting and processing replies from transponder equipped aircraft. Each test described below is designed to evaluate a particular facet of the beacon performance. The sections include Splits and False Reports, Range Resolution, Azimuth Resolution, Code Validation and Code Accuracy, and Pulse Width Discrimination.

The ARSR-4 beacon system performance (measured on targets of opportunity) is compared with the ARSR-3 performance in the "ARSR-4 versus ARSR-3 Comparison" section of this report.

Test Configuration

A Mode S enroute beacon antenna (type FA10250), in the single array configuration, was chin mounted on the Mt. Laguna ARSR-4 antenna. The beacon antenna tilt was adjusted to zero degrees.

The ARSR-4 was interfaced to an ATCBI-5. The ATCBI-5 was operated in asynchronous mode. The beacon PRF was 265 Hertz (Hz). The mode interlace pattern was 3/A, 2, 3/A, C. The ATCBI-5 was optimized to operate within standard blue sheet tolerances.

The ARSR-4 beacon Interrogate/Reply Criteria SAP/FAPs were configured as shown in table 4.1.11-1: No runlength discrimination sectors were enabled during the tests. The ARSR-4 beacon code and garble tolerance parameter settings are shown in table 4.1.11-2.

TABLE 4.1.11-1. ARSR-4 BEACON DETECTION PARAMETERS

Parameter	Setting
Alarm Detection Window (N)	10 (5 to 20)
Successive interrogations w/o associating target reply	8 (4 to 8)
Total Matching Replies to declare mode valid for report	2 (1 to 6)
Total missed code matches before split into two targets	6 (1 to 12)
Mode	Hits
3/A	3
2	10
3/A and 2	10
C and 2	10
3/A and C	10
3/A, 2, and C	10

TABLE 4.1.11-2. ARSR-4 BEACON CODE AND GARBLE TOLERANCES

ARSR-4 SAP/FAP Settings	Range Cells
Bracket Tolerance	2
Code Data Sampling Tolerance	2
Garble Tolerance	4
Maximum Pulsewidth Before Trail Edge Detection	9

Most of the tests described in this section were performed by injecting RF beacon test targets into the ATCBI-5 through a test port at the front of the receiver/transmitter unit. A Sensis Radio Frequency Beacon Interrogator Test Set (RFBits) test target generator injected test target scenarios designed to verify beacon resolution, code validation and accuracy, and pulse width discrimination. The directional and omni connections to the antenna were disconnected during the test target tests.

4.1.11.1 Beacon Splits and False Reports

Purpose

Ensure that the ARSR-4 beacon target processor false report rate is within acceptable limits for operation in NAS.

Test Objective

Verify that the ARSR-4 outputs an acceptably low number of beacon splits and false reports.

Test Description

ARSR-4 target of opportunity data was collected at the user 1 ports using IRES. At the same time, ARSR-3 data was collected using an MX-6 recorder. Data was recorded for approximately 1 hour and 20 minutes during the test (designated RUN 535). The ARSR-4 operated with the 13JUN95 software build for the test.

A further comparison of the beacon performance between the two radars can be found in the "ARSR-4 versus ARSR-3 Comparison" section of this report.

Data Analysis

Each data file was analyzed using IRES. The data was first filtered to remove the regions where ARSR-4 beacon operation was blanked in the direction of the ARSR-3 tower (330 to 360°). The PREPPCS program sorted the data into range and azimuth order. PREPPCS also consolidated beacon reports with the same code (i.e., splits) and tagged the false beacon reports.

The FILTER program separated all beacon split reports into the same file. The COUNTPCS program counted the number of false beacon reports on each scan. The PLOTPCS program was used to plot only the split reports for each radar.

Results
Table 4.1.11.1-1 shows the results of ARSR-4 and ARSR-3 beacon split analysis for RUN 535. The table shows the validated mode 3/A and nonvalidated Mode 3/A split counts and the overall percentage of splits. The ARSR-4 beacon split rate was nine times higher than that of the ARSR-3 during the test with the majority of the splits containing a validated Mode 3/A code.

TABLE 4.1.11.1-1. RUN 535 ARSR-4 VS. ARSR-3 SPLITS

ARSR-3 Discrete Beacon				ARSR-4 Discrete Beacon			
Total Beacon	Val 3/A Splits	NonVal Splits	Split %	Total Beacon	Val 3/A Splits	NonVal Splits	Split %
60203	19	2	.03	64717	163	11	.27

The ARSR-4 beacon split rate fluctuated during the OT&E retest period. Some days the split rate was comparable to that of the ARSR-3. On other days, the ARSR-4 split rate was much greater than the ARSR-3 split rate.

Figures 4.1.11.1-1 and 4.1.11.1-2 show the beacon split reports plotted in a PPI format for the ARSR-3 and the ARSR-4, respectively. The excessive ARSR-4 beacon splits are concentrated between 50 and 150 nm in range and between 30° and 90° in azimuth. This area is in the direction of the Salton Sea. Figure 4.1.11.1-3 shows a RHI plot of the ARSR-4 splits. From the plot it is evident that the altitudes of the split reports vary.

Conclusions

a. The ARSR-4 has a significantly higher beacon split rate than the ARSR-3. The higher split rate often exceeds Quick Analysis of Radar Sites (QARS) tolerances which are used to certify the radar in NAS.

b. Most of the ARSR-4 splits are concentrated in the direction of the Salton Sea. The fluctuating ARSR-4 split rate during OT&E retest may be due to a combination of environmental effects from the Salton Sea and the wide beamwidth of the Mode S beacon antenna at Mt. Laguna.

Recommendations
The cause for the high ARSR-4 beacon split rate at Mt. Laguna should be identified and corrected.

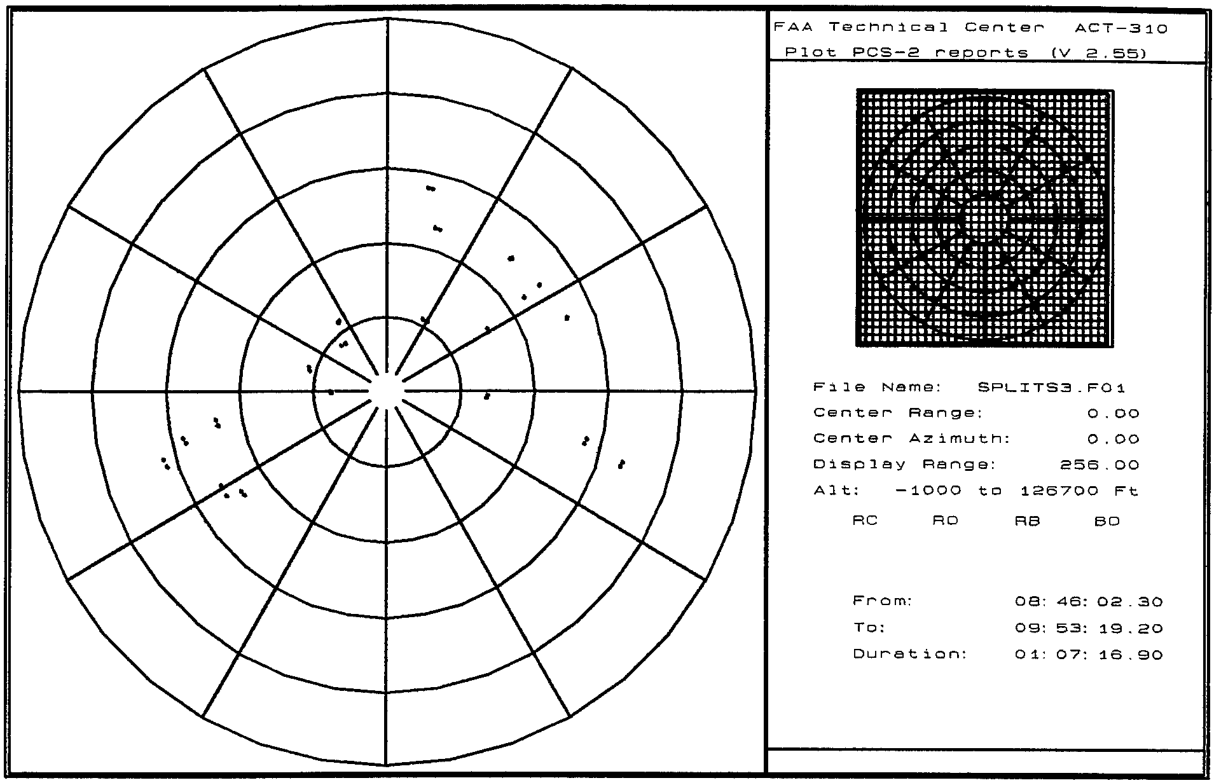

FIGURE 4.1.11.1-1 RUN 535 PLOTPCS - ARSR-3 SPLITS

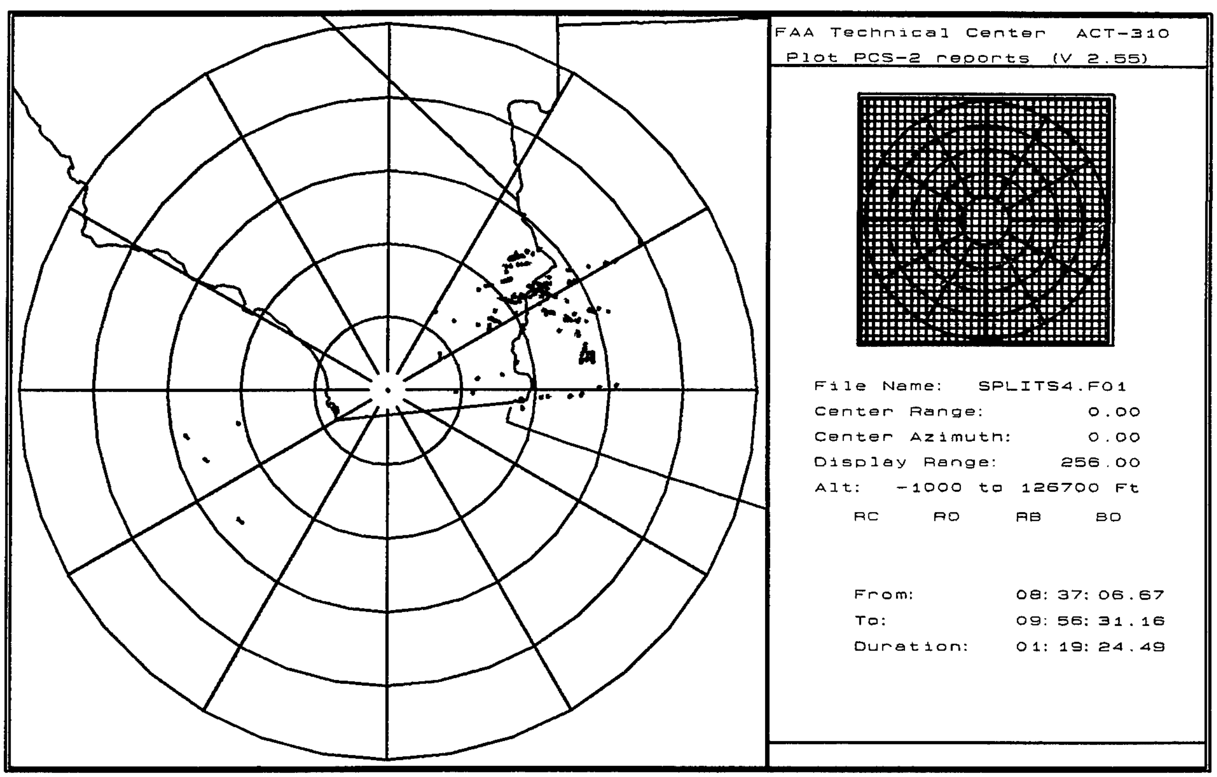

FIGURE 4.1.11.1-2 RUN 535 PLOTPCS - ARSR-4 SPLITS

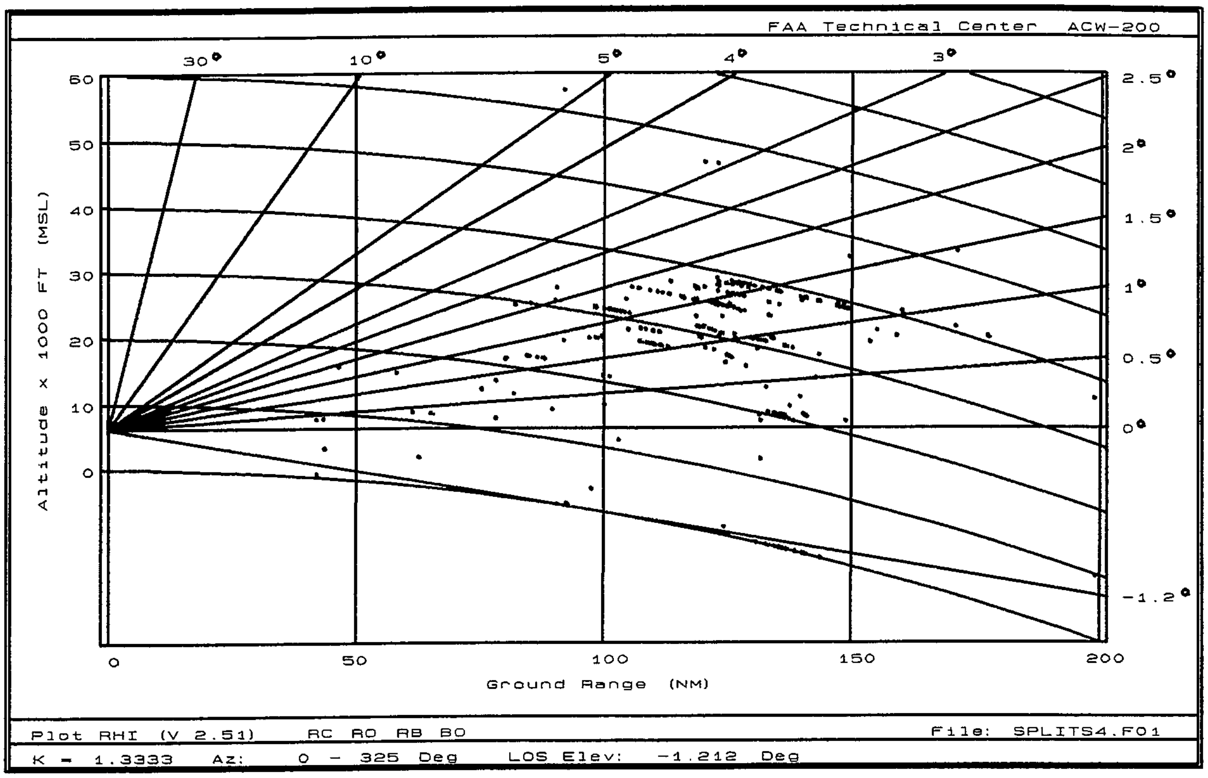

FIGURE 4.1.11.1-3 RUN 535 PLOTRHI - ARSR-4 SPLITS

4.1.11.2 Beacon Range Resolution.

Purpose

Ensure that the ARSR-4 BTP resolves beacon replies closely spaced in range.

Test Objectives

a. Verify that two or more beacon targets detected at the same azimuth but separated in range by more than 0.7 microseconds (μs), are reported as separate targets.

b. Verify that the target codes are validated and accurate when the range separation of the targets are such that their code or framing pulse positions overlap (at 50 percent amplitude points) by 90 nanoseconds (ns) or less.

Test Description

Table 4.1.11.2-1 describes the beacon test target scenarios used in the range resolution test. Four scenarios were used. Each scenario was injected into the ATCBI-5 directional test port using a Sensis RFBits. Each scenario included 20000 False Replies Unsynchronous In Time (FRUIT) / scan. The RFBits beacon test set had a 20 megahertz (MHz) clock. Therefore, the precision of the range data is 50 nsec.

RANGE001, RANGE002, and RANGE003 were designed to measure the ability of the ARSR-4 to provide two separate beacon reports for reply trains separated by .6 μs, .7 μs, and .8 μs. There was no code pulse interference in these scenarios.

RANGE004 measured the ability of the ARSR-4 beacon target processor to properly extract the codes of injected replies when the code pulses overlapped by varying amounts. Six pairs of targets were injected, with each pair at a different azimuth. The range separation for targets in each pair was greater than the .7 μs range resolution requirement. The amount of pulse overlap varied from one pair to another.

Data Analysis

Fifty scans of CD-2 data were recorded at the user 1 output ports for each injected scenario. The data was analyzed using IRES. The data was first filtered to include 49 full scans.

For RUNs 287-289, the SHOWPCS and COUNTPCS programs were used to count the number of beacon reports output on each scan and inspect the codes in the reports. For RUN 290, the data was also filtered by azimuth to separate the data with different pulse overlaps during the test.

Results

Table 4.1.11.2-2 shows the beacon report counts for RUNs 287-289. On each scan, the ARSR-4 output at least 12 beacon reports. The Mode 3/A codes were correct and validated 100 percent of the time. The ARSR-4 successfully detected beacon replies separated by .7 μs in range.

TABLE 4.1.11.2-1. BEACON RANGE RESOLUTION TEST SCENARIOS

RUN	Scenario	Description
287	RANGE001	6 pairs of test targets with each pair separated by .6 us. Azimuth increments by 60 degrees between pairs. Range movement = 100 nm/hr. Interrogate on modes 3/A, 2, 3/A, C. Reply to modes 3/A, 2. Round Reliability at 100%.
288	RANGE002	same as RANGE001 with .7 us separation of targets within each pair.
289	RANGE003	same as RANGE001 with .8 us separation of targets within each pair.
290	RANGE004	6 pairs of test targets with each pair separated by a different range such that the framing, code, X or SPI pulses overlap. Reply on Mode 3/A only. Range movement = 100 nm/hr.

Target	Range (usec)	Azimuth (degrees)	3/A Code	Overlap (nsec)
1	617.75	0	2510SX	50
2	618.80	0	5430SX	-
3	617.75	60	7700X	100
4	618.85	60	7600S	-
5	617.75	120	7777SX	150
6	618.90	120	7700	-
7	617.75	180	7777SX	0
8	619.65	180	7700	-
9	617.75	240	7777SX	None
10	619.70	240	7700	-
11	617.75	300	7777SX	50
12	619.60	300	7700	-

On scan 31 of RUN 287 and scan 25 of RUN 289, the ARSR-4 output 13 beacon reports for the 12 targets injected. These two azimuth split reports had validated Mode 3/A codes. The two splits divided by the total number of beacon reports (1764) corresponds to a .11 percent split rate during the three tests.

TABLE 4.1.11.2-2. RUNS 287-289 BEACON REPORT COUNTS

RUN	Range Separation (usec)	Average Reports Per Scan
287	.6	12.02
288	.7	12.00
289	.8	12.02

Table 4.1.11.2-3 shows the results for RUN 290 for the RANGE004 scenario. The data was filtered to include 49 complete scans of data and to isolate targets along each radial. Therefore, since there were two targets injected along each radial, the expected number of beacon reports on each radial is 98.

TABLE 4.1.11.2-3. RUN 290 OVERLAPPING PULSES

Azimuth (Deg.)	Pulse Overlap (nsec)	Beacon Reports	Correct 3/A Code		Incorrect 3/A Code	
			Val.	Inval.	Val.	Inval.
0	50	99*	93	4	1*	1
60	100	98	56	24	0	18
120	150	98	25	36	0	37
180	0	98	94	4	0	0
240	None	98	98	0	0	0
300	50	97	29	42	0	26

Since the targets were separated by more than the .7 μs range resolution requirement, the data shows a good percent detection. There was one extra report along the 0° radial (denoted in the table with an asterisk). The extra report contained an incorrect Mode 3/A code which was validated. There was one missed detection on the 300° radial.

With no pulse overlap (240°), all of the beacon reports contained the correct and validated Mode 3/A codes. When the trail edge of one target's reply pulses were aligned with the lead edge of the second target's reply pulses (180°), all of the beacon reports had the correct codes and 96 percent of the codes were validated.

Targets were positioned such that their reply pulses overlapped by 50 ns on two different radials (0° and 300°). On the 0° radial, 95 percent of the reports had the correct and validated code. On the 300° radial, only 30 percent of the beacon reports contained the correct and validated Mode 3/A code. The lower validation percentage on the 300° radial may be due to the test target Mode 3/A codes on that radial (i.e., 7777 and 7700 codes produce more pulse interference opportunities than 2510 and 5430). All of the incorrect, invalidated reports on the 300° radial contained 0000 codes.

As expected, the radials whose targets had 100 ns and 150 ns pulse overlap showed a lower percentage of correct and validated codes.

Conclusions

a. The ARSR-4 beacon processor detects and reports two targets at the same azimuth and separated by 0.7 μs or more in range.

b. The ARSR-4 reports Mode 3/A codes that are validated and accurate when the code pulses of the test targets were overlapped by 50 ns.

4.1.11.3 Beacon Azimuth Resolution.

Purpose

Ensure that the ARSR-4 BTP resolves beacon replies closely spaced in azimuth.

Test Objectives

a. Verify that two stationary, identical targets which are within 0.576 nm in range and separated by an absence of beacon replies for 18 Pulse Repitition Time (PRT)s are detected as separate targets at least 95 percent of the time.

b. Verify that two detected, 11 hit per mode noninterfering targets which are within 0.05 nm in range, have one or more distinguishing characteristics, and are adjacent in azimuth with no intervening PRTs are resolved at least 99.5 percent of the time. Distinguishing characteristics include different Mode 2, 3/A, or C codes.

Test Description

Test targets were injected into the ATCBI-5 to test the ARSR-4 beacon processor azimuth resolution. CD-2 data was collected at the output of the ARSR-4 using IRES.

Table 4.1.11.3-1 shows the beacon scenarios used in the azimuth resolution test. The AZRES001, AZRES002, and AZRES003 scenarios each contained six pairs of targets. The identical targets in each pair were positioned at same range. The azimuth separation between targets in each pair varied from 17 to 19 PRTs between scenarios.

The round reliability of the test targets was set to 76 percent for the AZRES001-AZRES003 tests. Round reliability is the probability of a target replying to an interrogation. In the real world, this probability is less than one due to shielding of aircraft beacon antenna during turns, interrogations during a transponder's dead time, etc.

The AZRES005 and AZRES006 scenarios each contain six pairs of targets which are adjacent in azimuth (i.e., no PRT separation) with one distinguishing difference between the targets. In AZRES005, adjacent targets are at altitudes that differ by more than 100 feet. In AZRES006, the adjacent targets have different mode 3/A and 2 codes.

Data Analysis

Fifty scans of CD-2 data were recorded at the user 1 output ports for each injected scenario. The data was analyzed using IRES. The SHOWPCS and COUNTPCS programs were used to count the number of beacon reports output on each scan and to inspect the codes in the reports.

TABLE 4.1.11.3-1. BEACON AZIMUTH RESOLUTION TEST SCENARIOS

<table>
<tr><th>RUN</th><th>Scenario</th><th>Description</th></tr>
<tr><td>292</td><td>AZRES001</td><td>6 pairs of stationary targets at 100 nm, separated by 18 PRTs with targets of each pair identical in mode, code and altitude. Round Rel = 76%. Runlength=31 ACPs
<table>
<tr><th>Pair</th><th>Mode 3/A code</th><th>1st Start Az</th><th>2nd Start Az</th></tr>
<tr><td>1</td><td>5430SX</td><td>100 ACPs</td><td>154 ACPs</td></tr>
<tr><td>2</td><td>4530SX</td><td>300 ACPs</td><td>354 ACPs</td></tr>
<tr><td>3</td><td>5340SX</td><td>500 ACPs</td><td>554 ACPs</td></tr>
<tr><td>4</td><td>4620SX</td><td>700 ACPs</td><td>754 ACPs</td></tr>
<tr><td>5</td><td>6210SX</td><td>900 ACPs</td><td>954 ACPs</td></tr>
<tr><td>6</td><td>7700SX</td><td>1100 ACPs</td><td>1154 ACPs</td></tr>
</table></td></tr>
<tr><td>293</td><td>AZRES002</td><td>same as AZRES001 with start az sep of 53 ACPs (17 PRT absence).</td></tr>
<tr><td>294</td><td>AZRES003</td><td>same as AZRES001 with start az sep of 55 ACPs (19 PRT absence).</td></tr>
<tr><td>296</td><td>AZRES005</td><td>6 pairs of stationary targets at 100 nm with targets of each pair within .05 nm of each other replying to the same modes with altitudes differing by more than 100 ft.
<table>
<tr><th>Target</th><th>M2 Code</th><th>M3 Code</th><th>Azimuth (ACP)</th><th>Range (nm)</th><th>Altitude (KFT)</th></tr>
<tr><td>1</td><td>4630</td><td>5630</td><td>100</td><td>100.0</td><td>25000</td></tr>
<tr><td>2</td><td>4630</td><td>5630</td><td>158</td><td>100.03</td><td>25200</td></tr>
<tr><td>3</td><td>4631</td><td>5631</td><td>300</td><td>100.0</td><td>25000</td></tr>
<tr><td>4</td><td>4631</td><td>5631</td><td>358</td><td>100.03</td><td>24500</td></tr>
<tr><td>5</td><td>4632</td><td>5632</td><td>500</td><td>100.0</td><td>25000</td></tr>
<tr><td>6</td><td>4632</td><td>5632</td><td>558</td><td>100.03</td><td>36500</td></tr>
<tr><td>7</td><td>4633</td><td>5633</td><td>700</td><td>100.0</td><td>25000</td></tr>
<tr><td>8</td><td>4633</td><td>5633</td><td>758</td><td>100.03</td><td>4500</td></tr>
<tr><td>9</td><td>4634</td><td>5634</td><td>900</td><td>100.0</td><td>25000</td></tr>
<tr><td>10</td><td>4634</td><td>5634</td><td>958</td><td>100.03</td><td>20500</td></tr>
<tr><td>11</td><td>4635</td><td>5635</td><td>1100</td><td>100.0</td><td>25000</td></tr>
<tr><td>12</td><td>4635</td><td>5635</td><td>1158</td><td>100.03</td><td>25500</td></tr>
</table></td></tr>
<tr><td>297</td><td>AZRES006</td><td>6 pairs of stationary targets at 100 nm with targets of each pair within .05 nm of each other replying to the same modes with different 3/A or 2 codes.
<table>
<tr><th>Target</th><th>M2 Code</th><th>M3 Code</th><th>Azimuth (ACP)</th><th>Range (nm)</th></tr>
<tr><td>1</td><td>4630</td><td>5630</td><td>100</td><td>100.0</td></tr>
<tr><td>2</td><td>4630</td><td>5610</td><td>158</td><td>100.03</td></tr>
<tr><td>3</td><td>4631</td><td>5631</td><td>300</td><td>100.0</td></tr>
<tr><td>4</td><td>4611</td><td>5631</td><td>358</td><td>100.03</td></tr>
<tr><td>5</td><td>4632</td><td>5632</td><td>500</td><td>100.0</td></tr>
<tr><td>6</td><td>4632</td><td>5432</td><td>558</td><td>100.03</td></tr>
<tr><td>7</td><td>4633</td><td>5633</td><td>700</td><td>100.0</td></tr>
<tr><td>8</td><td>4733</td><td>5633</td><td>758</td><td>100.03</td></tr>
<tr><td>9</td><td>4634</td><td>5634</td><td>900</td><td>100.0</td></tr>
<tr><td>10</td><td>4634</td><td>5630</td><td>958</td><td>100.03</td></tr>
<tr><td>11</td><td>4635</td><td>5635</td><td>1100</td><td>100.0</td></tr>
<tr><td>12</td><td>4637</td><td>5635</td><td>1158</td><td>100.03</td></tr>
</table></td></tr>
</table>

Results

Table 4.1.11.3-2 shows the average number of beacon reports output on each scan during Runs 292-294. On most scans, the ARSR-4 output 12 beacon reports. The Mode 3/A codes were correct and validated 100 percent of the time.

The data were further studied to determine the cause for the "missing reports" from the data file. In all cases, when one target of a pair was reported, it had the correct azimuth. This indicates that the "missing reports" were not due to lack of azimuth resolution. The reports absent from the data file were due to the 76 percent round reliability imposed on the target scenarios (i.e., those targets were never injected into the ATCBI-5). The ARSR-4 successfully resolved stationary, identical beacon replies for each azimuth separation 100 percent of the time during the test.

TABLE 4.1.11.3-2. RUNS 292-294 AVERAGE BEACON REPORT COUNTS

RUN	Azimuth Separation (PRT)	Average Reports Per Scan
292	17	11.73
293	18	11.77
294	19	11.74

Table 4.1.11.3-3 shows the results when the AZRES005 scenario was injected. The adjacent targets in each pair had different Mode C altitudes. The remaining characteristics of the targets were identical.

The first column in the table shows the altitude differences between the adjacent targets in each pair. The resolution opportunities column contains the number of times that two targets were injected into the ATCBI-5 at each altitude (the 76 percent round reliability effects were removed from analysis).

The combined resolution percentage for all altitude differences was 97.2 percent. Although this value does not meet the 99.5 percent requirement, the effects would go unnoticed operationally since two real targets will most likely have other differing characteristics.

TABLE 4.1.11.3-3. RUN 296 - BEACON AZIMUTH RESOLUTION - DIFFERENT MODE C ALTITUDES

Altitude Difference (Hundred Feet)	Resolution Opportunities	Resolution Percentage
200	50	96
500	99	100
4500	47	100
11500	50	92
20500	50	96

Table 4.1.11.3-4 shows the results when the AZRES006 scenario was injected. Six pairs of adjacent targets were injected into the ATCBI-5 each scan. The targets in three of the pairs were identical except for Mode 3/A code. The targets in the other three pairs were identical except for Mode 2 code.

The data shows that when the adjacent targets contained different Mode 3/A codes, the ARSR-4 resolved the targets each time. All of the Mode 3/A and Mode 2 codes were correct and validated for this case.

When the adjacent targets contained different Mode 2 codes (and identical Mode 3/A codes), the resolution percentage dropped to 96 percent. Although this value does not meet the 99.5 percent requirement, the effects would go unnoticed operationally since two real targets will most likely have other differing characteristics.

TABLE 4.1.11.3-4. RUN 297 - RESPONDING WITH DIFFERENT CODES

Different Mode 3/A Codes		Different Mode 2 Codes	
Resolution Opportunities	Resolution Percentage	Resolution Opportunities	Resolution Percentage
150	100	150	96

Conclusions

a. The ARSR-4 beacon processor effectively resolves two stationary, identical targets which are within 0.576 nm in range of each other and separated by an absence of beacon replies for 18 PRTs.

b. The ARSR-4 beacon processor effectively resolved two 11-hit per mode noninterfering targets which were within 0.05 nm in range and differed only in Mode 3/A or Mode C code.

4.1.11.4 Code Validation and Code Accuracy.

Purpose

Ensure that the ARSR-4 beacon processor reports accurate beacon codes with a high validation rate.

Test Objectives

a. Verify that the ARSR-4 validates the beacon code information as contained in the aircraft's reply for Modes 2, 3/A, and C including SPI pulses at least 95 percent of the time when the number of actual hits received per mode is 11 or greater.

b. Verify that when the number of hits per mode is 15 or more, the codes are validated at least 98 percent of the time.

c. Verify that the validated codes are accurate at least 99 times out of 100.

d. Verify that the ARSR-4 beacon processor recognizes the false "phantom" brackets which can occur in the closely spaced reply condition when nonframing pulses in different replies occur at the framing interval.

Test Description

CD-2 data was recorded on the user 1 ports with IRES while beacon test targets were injected into the ATCBI-5. Three different beacon test target scenarios were used to measure the code validation and code accuracy performance of the ARSR-4 beacon processor. Table 4.1.11.4-1 describes each scenario.

VAL95SX tested the validation rate for all reply bits including the SPI and X bits when the test target runlengths were 56 ACPs. Since the beacon Pulse Repitition Frequency (PRF) was 265 Hz and the test targets replied to modes 3/A, 2, and C interrogations, the number of hits per mode is 11 for these scenarios.

VAL98SX tested the validation rate for all reply bits including the SPI and X bits when the test target runlengths were 77 ACPs. This corresponds to 15 hits per mode.

PHANTOM1 tested the ability of the ARSR-4 beacon processor to recognize phantom cases (i.e., those cases where the bracket pulses of one target reply align with the C2 and SPI pulses of the second target's replies. ARSR-4 contains six pairs of individual targets with C2-SPI interference.

TABLE 4.1.11.4-1. CODE VALIDATION AND CODE ACCURACY TEST SCENARIOS

RUN	Scenario	Description
300	VAL95SX	Sixteen spokes of ten targets each. The X and SPI bits were set for modes 2 and 3/A. Target Runlength = 56 ACPs. Round Reliability = 100%.
302	VAL98SX	same as VAL95SX except target runlength = 77 ACPs.
303	PHANTOM1	6 pairs of individual targets with C2-SPI pulse interference.

Data Analysis

The CD-2 data was analyzed using IRES. The COUNTPCS and SHOWPCS programs were used to inspect the beacon report codes and count the number of reports with the correct and validated codes.

Results

Table 4.1.11.4-2 shows the results when the VAL95SX (56 ACP runlength) and VAL98SX (77 ACP runlength) scenarios were injected into the ATCBI-5. There were 160 targets injected on each scan. Data was recorded for 50 scans during the test. The results show that the ARSR-4

reported the correct and validated code (including SPI bit) over 99 percent of the time during the test when the target runlength was 56 ACPs and 100 percent of the time when the test target runlength was 77 ACPs. The asterisks in the table denote cases of azimuth splits during the test with the longer runlengths.

TABLE 4.1.11.4-2. VAL95SX AND VAL98SX RESULTS

Target Runlength (ACPs)	Targets Injected	Correct and Validated Codes (including SPI) Mode 3/A	Mode 2	Mode C
56	8000	7978 (99.7%)	7966 (99.5%)	7971 (99.6%)
77	8000	8004* (100%)	8002* (100%)	8003* (100%)

Table 4.1.11.4-3 shows the results for the PHANTOM1 test. In each case, the ARSR-4 successfully identified the C2-SPI pulse interference. The correct code of one of the targets in each pair was extracted and validated. The code of the second target was set to zero each time.

TABLE 4.1.11.4-3. RUN 303 PHANTOM1 TEST SCENARIO

Beacon Targets Injected	Correct and Validated Mode 3/A Codes	Nonvalidated Zero Mode 3/A Codes
600	300	300

Conclusions

a. The ARSR-4 validates the beacon code information as contained in the aircraft's reply for Modes 2, 3/A, and C [including SPI pulses] at least 95 percent of the time when the number of actual hits received per mode is 11 or greater.

b. When the number of hits per mode is 15 or more, the codes were validated at least 98 percent of the time.

c. The validated codes were accurate at least 99 times out of 100.

d. The ARSR-4 beacon processor recognizes the false "phantom" brackets. The Mode 3/A code was successfully extracted for one target, while the code was correctly set to zero for the interfering target.

4.1.11.5 Pulse Width Discrimination.

Purpose
Ensure that the pulse width discrimination functions in the ARSR-4 beacon target processor operate properly.

Test Objective
Verify that the ARSR-4 rejects beacon pulses with less than a 150-ns pulse width and accepts pulses with greater than 300-ns pulse width.

Test Description
One beacon scenario, PULSE003, was used to measure the ARSR-4 beacon pulse width discrimination. The scenario is shown in table 4.1.11.5-1. Twelve targets were injected at different azimuths. The bracket and code pulse widths remained constant for each target reply, but varied from one target to another.

Fifty scans of CD-2 data were recorded at the user 1 output using IRES (RUN 243).

TABLE 4.1.11.5-1. PULSE WIDTH DISCRIMINATION TEST SCENARIO

Scenario	Description		
PULSE003	Twelve individual targets injected. Each target reply has the same pulse width for all bracket and code pulses.		
	Target	Pulse Width (nsec)	Azimuth (deg)
	1	50	30
	2	100	60
	3	150	90
	4	200	120
	5	250	150
	6	300	180
	7	350	210
	8	400	240
	9	450	270
	10	500	300
	11	550	330
	12	600	355

Data Analysis
The recorded data was inspected using the IRES SHOWPCS and PLOTPCS programs.

Results
Figure 4.1.11.5-1 shows a PPI plot of the beacon reports in RUN 243. The data shows that beacon replies were not detected when the reply pulse width was less than 250 ns. At a 250 ns pulse width, five beacon reports were output. For pulse widths greater than 250 ns, beacon reports were output on each scan.

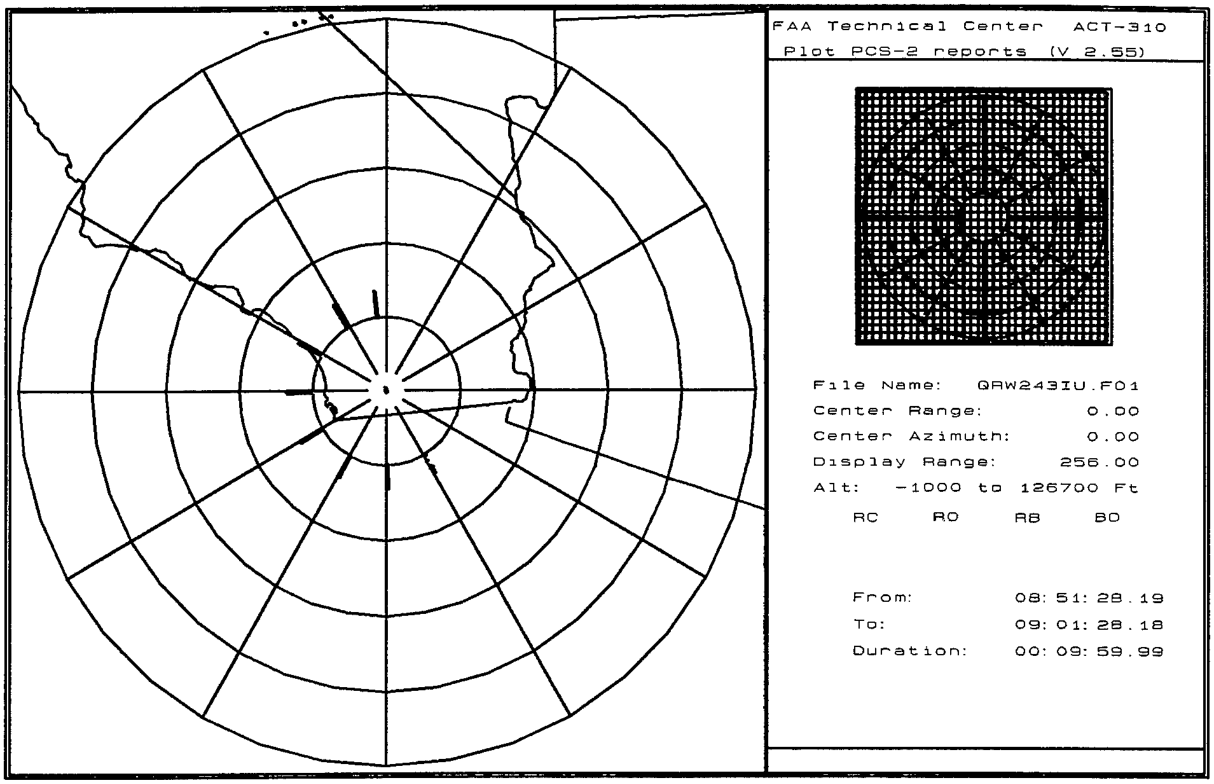

FIGURE 4.1.11.5-1 RUN 243 - PULSE WIDTH DISCRIMINATION

Conclusions
The ARSR-4 effectively rejects beacon reply pulse widths less than 250 ns and accepts pulse widths greater than 300 ns.

4.1.12 Surveillance Capacity and Delay.

Purpose
Ensure that the ARSR-4 can adequately process a capacity target load within specified delay times.

Test Objectives

a. Verify that, when the ARSR-4 is not colocated with the Mode S system, the overall data delay from the antenna peak of beam to report being available at the input to the modems is 1.5 seconds or less during peak capacity conditions.

b. Verify that the ARSR-4 can process and provide message outputs for a steady state maximum load of 800 aircraft returns within the primary radar coverage area.

c. Verify that the ARSR-4 can process and provide message outputs for a large sector peak consisting of 50 aircraft returns in each of eight contiguous 11.25° sectors.

d. Verify that the ARSR-4 can process and provide message outputs for a small sector peak consisting of 20 aircraft returns in each of three contiguous 1.2° sectors.

e. Verify that the ARSR-4 can process and provide message outputs for a azimuth peak of 60 aircraft returns aligned in an azimuth radial.

f. Verify that the ARSR-4 can process and provide message outputs for a range distribution peak of four aircraft returns within a 4.5 nm interval not equally spaced.

Test Description
The ARSR-4 successfully completed extensive capacity and delay tests during DT&E Software Performance Qualification Test (SPQT) 16. SPQT 16 addressed nine test cases. The test cases are listed in table 4.1.12-1.

TABLE 4.1.12-1. DT&E SPQT 16 TEST CASES

Test Case	Description
01	Capacity and Delay (Small Sector Peak and Range Distribution Peak without Mode S)
02	Capacity and Delay (Small Sector Peak and Range Distribution Peak with Mode S)
03	Capacity and Delay (Azimuth Peak without Mode S)
04	Capacity and Delay (Azimuth Peak with Mode S)
05	Capacity and Delay (Large Sector Peak without Mode S)
06	Capacity and Delay (Large Sector Peak with Mode S)
07	Radar Only Report Elimination Under Target Overload Conditions
08	CPU Reconfiguration with Capacity
09	GRAM Reconfiguration with Capacity

Capacity scenarios of search, beacon, Mode 4, and FRUIT were injected into the ARSR-4 along with 194 false search targets per scan during the DT&E test. The ARSR-4 search test target generator (STTG) and a separate beacon test target generator were used to inject the test targets. An ARSR-4 test set simulated the Mode S, recorded CD-2 reports, and compared the number and position of the reports to expected values. The test set also measured the processing delay of each report from antenna boresight to output from the radar.

During OT&E, a subset of the DT&E SPQT 16 tests were repeated. There were several differences in the test methods between the SPQT 16 and OT&E tests. First, since the Mode S was not available at Mt. Laguna, only tests with an ATCBI-5 configuration were performed during OT&E. Also, the capability to inject Mode 4 test targets was not available at Mt. Laguna. Finally, unlike the SPQT test, the OT&E capacity and delay tests were performed with the ARSR-4 second function tracker enabled, since this was the operational configuration at Mt. Laguna.

Figure 4.1.12-1 shows the OT&E test configuration. The beacon test target scenarios were designed using a PC-based, Sensis VideoBITS. VideoBITS produced beacon reply video which modulated the RF generator of a UPM-155 beacon test set. The resultant RF beacon test targets were then injected into the ATCBI-5 through a test port at the front of the receiver/transmitter unit. After ATCBI-5 downconversion, the quantized video output was then fed to the ARSR-4 beacon processor along with the mode pair triggers.

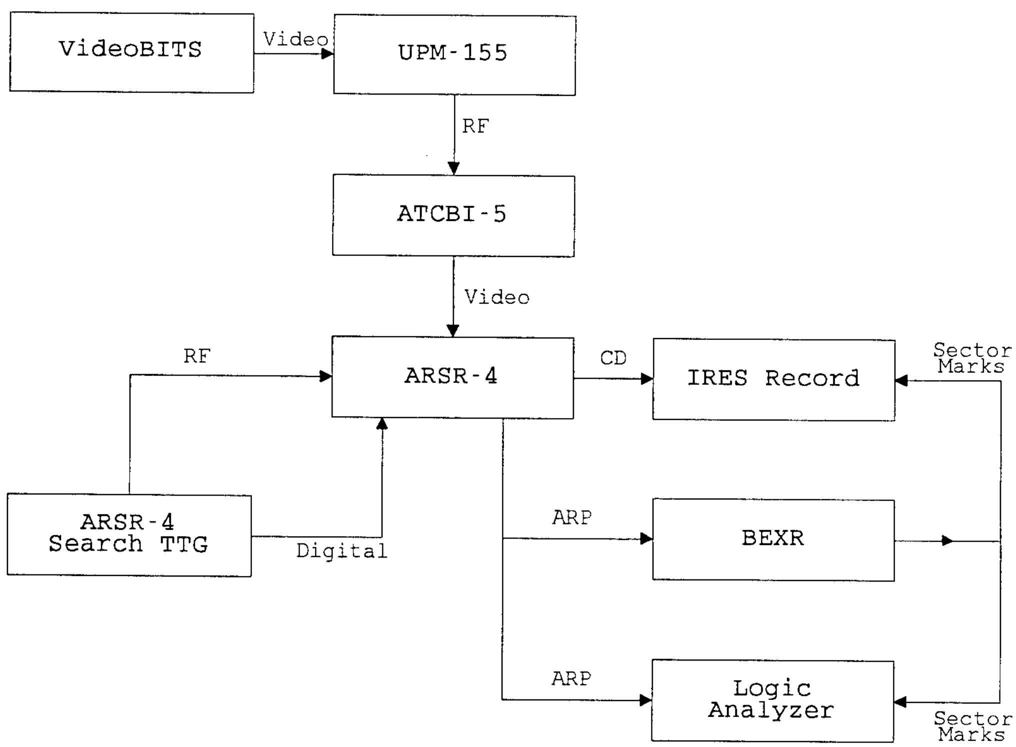

FIGURE 4.1.12-1 . CAPACITY AND DELAY TEST CONFIGURATION

The ARSR-4 search STTG injected both RF and digital test targets into the ARSR-4. The start and stop range, start and stop azimuth, range movement, and azimuth movement were adjustable via the LDC/RMS.

ARSR-4 CD-2 data were recorded using IRES connected to the user one ports (AF1 and AF2). Two user ports fed data to the IRES recorder at 9600 bps each. To measure target delay, sector mark messages, generated by a Sensis Beacon Extractor and Recorder (BEXR) were input to the third channel of IRES. Sixty-four sector mark messages were generated in each scan and evenly distributed throughout the scan. All recorded messages were time tagged by the IRES recorder and saved in the same surveillance file.

The ARSR-4 ARP triggered BEXR, thus giving an antenna azimuth reference to the generated sector marks. The ARP also fed a logic analyzer along with the generated sector marks. The logic analyzer measured the latency between the ARP and sector mark zero to determine the BEXR delay in generating the sector marks. The measured BEXR delay was then subtracted from report delay calculations during analysis.

Data was recorded with a computer connected to the ARSR-4 MPS port. The data included ARSR-4 alarms and any reconfiguration of on-line elements during the test.

The ATCBI-5 transmitter was turned off for the tests. The OMNI and DIR antenna cables were disconnected to prevent reception of live beacon replies. The ARSR-4 and ARSR-3 transmitters were disabled to reduce the number of live search targets received by the radar.

Table 4.1.12-2 describes each of the OT&E capacity and delay tests performed. The OT&E tests were performed with the 13JUN95 software build in the system.

TABLE 4.1.12-2. OT&E CAPACITY AND DELAY TESTS

Run	Description
541	790 search and 800 beacon test targets injected. Search targets had range movement of 300 knots. ARSR-3 transmitter off.
595	60 search and 12 beacon targets aligned along the same azimuth radial.

Run 541 was performed with a scan capacity of 790 search and 800 beacon targets injected. The search test targets consisted of 73 radials, each with 10 RF targets and a single radial with 60 digital test targets injected. The search test targets were given range movement so that they were tracked and output from the second function tracker.

The 800 beacon test targets consisted of 80 spokes of 10 test targets each. The spoked beacon test targets were stationary. There was no FRUIT injected for this test.

Run 595 tested the azimuthal capacity of the ARSR-4. Sixty digital search test targets and 12 beacon targets were injected. There was no FRUIT injected for this test.

Data Analysis

For capacity analysis, report counts were compared to the expected inputs from the STTGs. The IRES COUNTPCS and SCANSUM programs produced report counts per scan. The PLOTSCAN program produced a graphical representation of report counts per scan.

The FIXSECTR, CMPDELAY, and DELAY programs in IRES were used in delay analysis. FIXSECTR reformatted the sector marks (which appear as ARSR-4 RTQC messages) into IRES formatted sector marks. CMPDELAY computed the delay of each report. A linear interpolation using report azimuth and time was performed on all surveillance reports. Consecutive sector marks were used for true azimuth reference in the calculation.

The DELAY program plotted the computed delays in a histogram format versus time. Counts for the different report types were displayed using different colors. DELAY also displayed the maximum delay for each report type.

Results

Run 541 contained 100 scans of data with 790 search and 800 beacon test targets injected. Figure 4.1.12-2 shows a graphic representation of reports per scan. The upper plot in the figure shows the radar only report counts (upper trace), beacon only report counts (middle trace), and radar-beacon merge report counts (lower trace) per scan. The data shows a periodic drop in the search and beacon reports per scan coincident with a rise in the number of merged reports per scan. Since the search targets had motion and the beacon targets were stationary during the test, the merge rate was low.

The lower plot in figure 4.1.12-2 shows the status message and beacon RTQC report counts per scan. The ARSR-4 output a beacon RTQC on each scan. Note that while the ARSR-4 is in maintenance mode to support search test target injection, search RTQCs are not output from the ARSR-4 and are not seen in the figure.

The number of status messages per scan fluctuated. The bits in the CD-2 status message which changed during the test include the Beacon RTQC Alarm (BRTQCA), Beacon Channel On-line (BCOL), Mode 4 Alarm (M4ALA), Weather Channel Status (WXCHST), and Port Status alarms (P04STA, P03STA). Data collected at the MPS monitor showed no ARSR-4 alarm activity in the beacon, Mode 4, weather channel or user 1 IRES ports during the test. There were no indications of channel reconfigurations during the test. There were also no indications of buffer overflow or overload conditions for user 1. Therefore, the toggled bits in the status message during the test were not consistent with status reported at the MPS. The toggled bits in the CD-2 status message were erroneous.

Table 4.1.12-3 lists the report counts for RUN 541. The ARSR-4 reported 740 beacon reports (BO plus radar reinforced (RR)) on each scan. A military map (used to suppress beacon reflections from the ARSR-3 tower) was enabled during the test. The map filtered the output of beacon reports from 330° to 0°. Therefore, the expected number of beacon reports per scan was 740 rather than the 800 injected targets. The ARSR-4 output the expected number of beacon reports throughout the test.

TABLE 4.1.12-3. RUN 541 REPORTS PER SCAN

Scan	RO	BO	RR	Stat	Total	Scan	RO	BO	RR	Stat	Total
1	740	740	0	4	1549	51	763	740	0	3	1571
2	774	740	0	7	1586	52	783	740	0	1	1589
3	690	651	89	1	1496	53	688	661	79	1	1494
4	751	732	8	1	1557	54	751	732	8	3	1559
5	763	740	0	6	1574	55	762	740	0	1	1568
6	763	740	0	1	1569	56	761	740	0	1	1567
7	784	740	0	1	1590	57	782	740	0	1	1588
8	690	661	79	1	1496	58	690	654	86	1	1496
9	752	732	8	5	1562	59	754	732	8	3	1562
10	761	740	0	1	1567	60	761	740	0	1	1567
11	762	740	0	1	1568	61	760	740	0	1	1566
12	784	740	0	1	1590	62	779	740	0	1	1585
13	690	655	85	1	1496	63	693	654	86	5	1503
14	755	732	8	4	1564	64	753	732	8	3	1561
15	759	740	0	4	1568	65	763	740	0	4	1572
16	761	740	0	1	1567	66	764	740	0	2	1571
17	781	740	0	3	1589	67	783	740	0	1	1589
18	690	651	89	4	1499	68	690	661	79	4	1499
19	753	732	8	5	1563	69	753	731	9	4	1562
20	764	740	0	1	1570	70	764	739	1	4	1573
21	765	740	0	4	1574	71	763	739	1	1	1569
22	783	740	0	1	1589	72	784	740	0	1	1590
23	689	661	79	1	1495	73	690	656	84	3	1498
24	754	732	8	5	1564	74	753	732	8	4	1562
25	762	740	0	2	1569	75	761	740	0	2	1568
26	762	740	0	1	1568	76	761	740	0	1	1567
27	785	740	0	1	1591	77	781	740	0	3	1589
28	690	653	87	1	1496	78	690	651	89	1	1496
29	754	732	8	5	1564	79	750	732	8	6	1561
30	761	740	0	2	1568	80	763	740	0	1	1569
31	760	740	0	1	1566	81	764	740	0	5	1574
32	781	740	0	1	1587	82	784	740	0	1	1590
33	690	650	90	1	1496	83	688	659	81	1	1494
34	752	732	8	1	1558	84	755	732	8	3	1563
35	763	740	0	3	1571	85	763	740	0	1	1569
36	764	740	0	2	1571	86	783	740	0	1	1589
37	782	740	0	1	1588	87	788	740	0	4	1597
38	697	659	81	4	1506	88	689	652	88	1	1495
39	754	732	8	4	1563	89	754	732	8	3	1562
40	764	740	0	1	1570	90	759	740	0	1	1565
41	763	740	0	1	1569	91	781	740	0	5	1591
42	784	740	0	3	1592	92	784	740	0	1	1590
43	687	650	90	1	1493	93	694	654	86	5	1504
44	754	732	8	2	1561	94	752	732	8	5	1562
45	761	740	0	2	1568	95	763	740	0	3	1571
46	761	740	0	1	1567	96	782	740	0	1	1588
47	782	740	0	4	1591	97	776	731	9	3	1584
48	691	651	89	4	1500	98	702	669	71	1	1508
49	754	732	8	3	1562	99	754	733	7	7	1566
50	764	740	0	1	1570	100	763	740	0	1	1569

Table 4.1.12-3 shows that the number of search (RO plus RR) reports varied each scan and never equaled the expected 790 reports. Further investigation into the apparent loss of search data revealed that there was an uneven movement of the search test targets into and out of the coverage area during the test. Therefore, the STTG did not consistently inject 790 targets per scan.

The data for RUN 541 was filtered to eliminate the effects of the moving targets on the fluctuating search report counts. Table 4.1.12-4 shows the number of missing search reports per scan after the movement effects were removed. The table only includes search data for the RF test targets. (i.e., 73 radials of 10 targets each). The table shows that the number of missing reports never exceeds 20 on a single scan. It can also be seen that the scans on which the number of missing reports exceeds 8 is nearly periodic.

TABLE 4.1.12-4. RUN 541 NUMBER OF MISSING SEARCH TARGETS PER SCAN

Scan	Missing Search Reports	Scan	Missing Search Reports	Scan	Missing Search Reports	Scan	Missing Search Reports
1	4	26	2	51	1	76	4
2	5	27	0	52	3	77	2
3	1	28	11	53	20	78	11
4	4	29	2	54	3	79	6
5	2	30	1	55	4	80	4
6	0	31	5	56	3	81	1
7	2	32	3	57	1	82	1
8	18	33	9	58	11	83	19
9	3	34	5	59	4	84	0
10	2	35	2	60	1	85	3
11	1	36	1	61	4	86	2
12	1	37	3	62	5	87	0
13	11	38	18	63	9	88	10
14	2	39	1	64	4	89	4
15	5	40	3	65	2	90	3
16	2	41	1	66	1	91	6
17	3	42	0	67	2	92	4
18	8	43	9	68	19	93	9
19	4	44	4	69	1	94	7
20	1	45	1	70	3	95	2
21	0	46	3	71	2	96	2
22	3	47	2	72	0	97	4
23	19	48	9	73	12	98	15
24	2	49	3	74	5	99	2
25	2	50	1	75	1	100	6

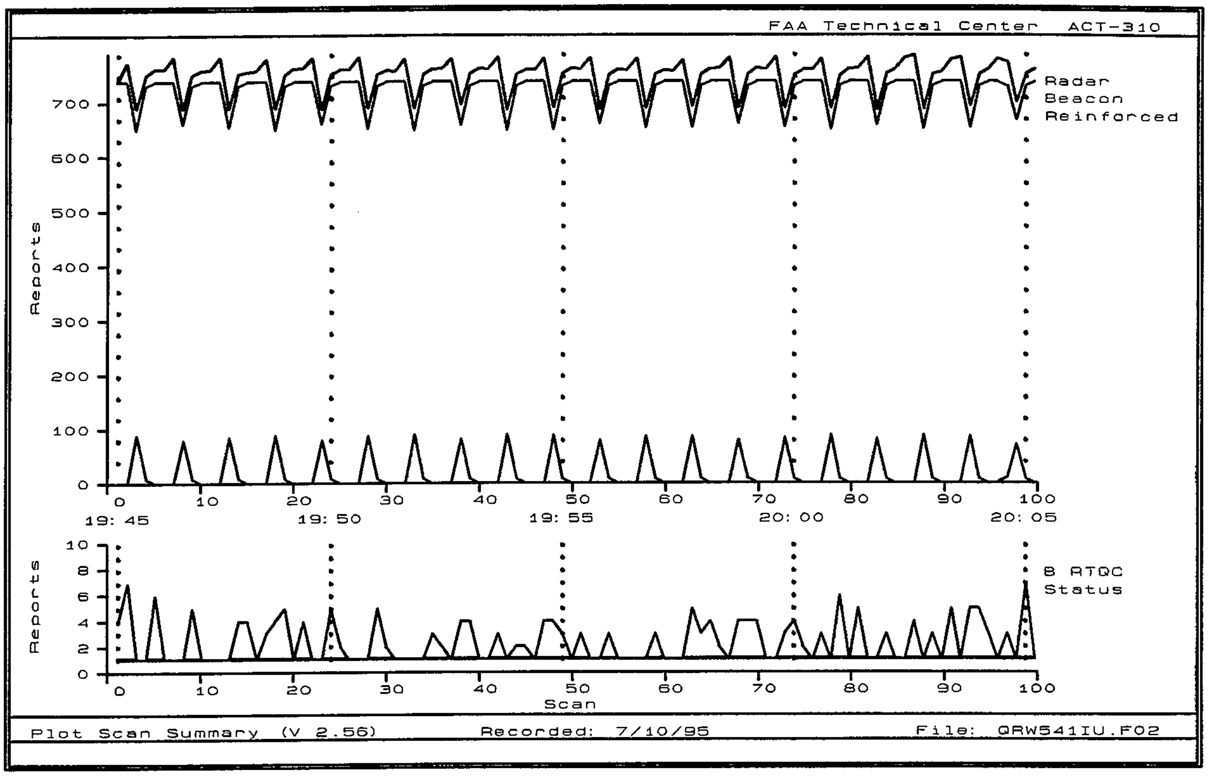

FIGURE 4.1.12-2 RUN 541 TARGET COUNTS VERSUS SCANS

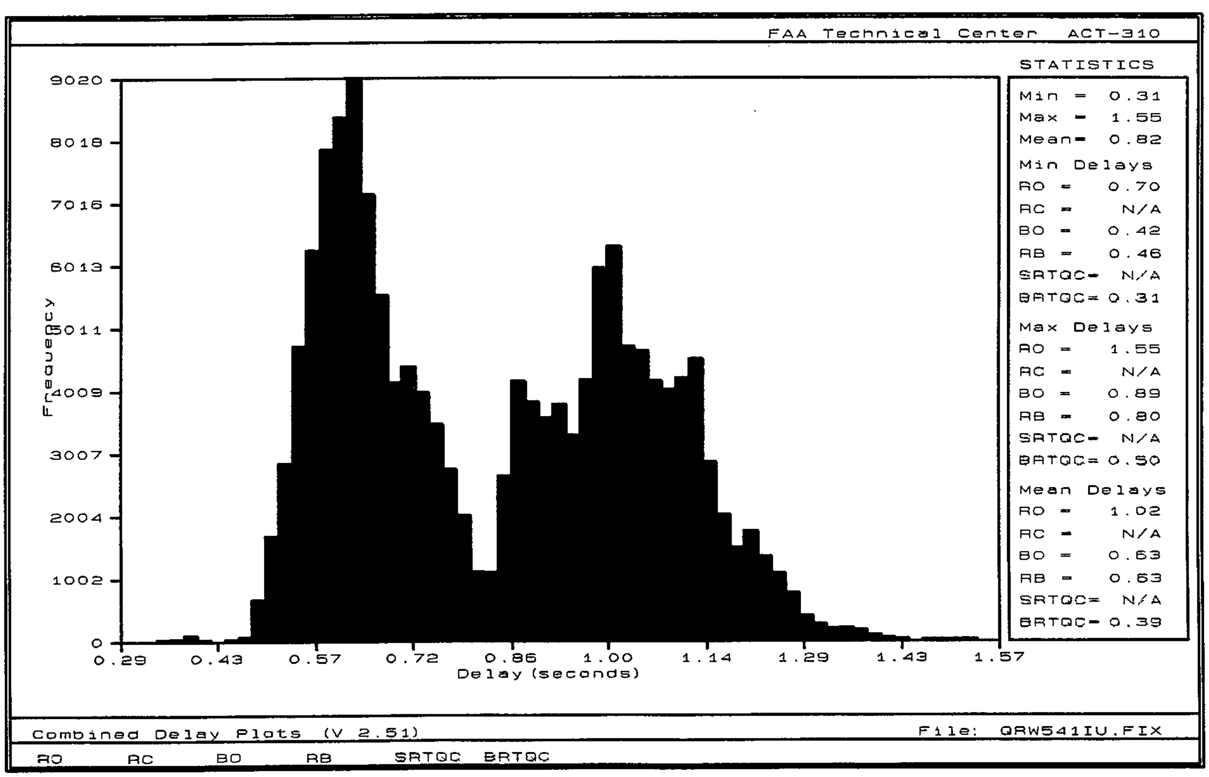

FIGURE 4.1.12-3 RUN 541 ARSR-4 REPORT DELAY DISTRIBUTION

The ranges and azimuths of the search reports missing from the recorded file were manually entered into a spreadsheet. Figure 4.1.12-4 shows the azimuth distribution of the missing search reports for the entire data file. Most of the search data losses in the area around 63, 120, and 262 degrees can be attributed to excessive attenuation by the geocensor map. These missing reports indicate a detection problem and not a capacity problem. The need for geocensoring in these areas is further discussed in the Surveillance Coverage and Primary False Alarm Rate sections of this report.

At greater azimuths (around 347°), individual radials of search reports were periodically lost throughout the data file. These missing search reports were the result of filtering of beacon reports by the military map set up from 330° to 0°. Due to the moving search test targets and stationary beacon test targets, the two types of targets periodically merged. A reinforced (and, therefore a search) report was not output from the system in this region.

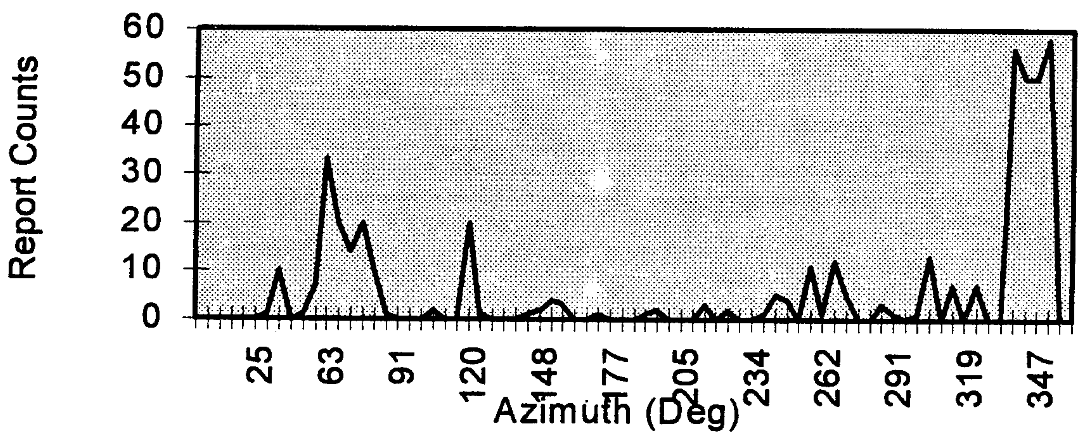

FIGURE 4.1.12-4. RUN 541 AZIMUTH DISTRIBUTION OF MISSING SEARCH REPORTS

Under the capacity load, the ARSR-4 lost some search targets but consistently output the expected number of beacon reports per scan. After eliminating the effects of the military map on the missing search reports, the number of missing search reports dropped below 1 percent per scan with most of those reports in areas with excessive geocensoring (a detection issue). The reporting of greater than 99 percent of the search targets during the test is most likely operationally acceptable.

The report delay was measured under the capacity conditions of RUN 541. Azimuth referenced, artificial sector marks were generated by BEXR and used as a source of true azimuth during the test. The delay from the ARSR-4 ARP to the BEXR sector mark 0 was monitored with a logic analyzer. The average sector mark latency (i.e., the BEXR delay) during RUN 541 was 54.12 ms and never varied by more than 10 ms during the test. This value is roughly two orders of magnitude less than the specified 1.5 second maximum delay, showing that the BEXR delay was negligible in the calculation.

The measured report delays were adjusted to account for the measured BEXR sector mark delay, the data transmission delay to the IRES recorder (since the 1.5 second requirement is to the input of the modems) and the delay in time tagging the reports in IRES.

The average BEXR sector mark delay (54 ms) was used in the delay adjustment. The data transmission delay for the longest message in the CD-2 format was used. At 9600 bps, the delay for the beacon message (seven words plus one idle word) is 10 ms. Finally, since the IRES recorder services an interrupt to flush its buffers every 7 ms, this number was subtracted from the report delay. The total delay adjustment used in analysis was 37 ms (i.e., 54-10-7).

Figure 4.1.12-3 shows the report delay distribution for Run 541 in a histogram format. There are three different report delay distributions in the figure. The BO distribution has the highest peak (and the least delay). The RO distribution has the second highest peak (and, as expected, has the greatest delay due to scan-to-scan correlation). The radar-beacon merged RB distribution is coincident with the beacon only distribution. The number of merged reports is low due to the inability to consistently align the moving search test targets with the stationary beacon test targets.

The right hand portion of the figure shows the minimum, maximum, and mean delays for each report type. The data shows that the maximum delays for each report type were within the 1.5-second requirement except the RO, where the maximum report delay was 1.55 seconds. Further investigation revealed that 11 RO reports exceeded the 1.5-second delay requirement during the test. All of the reports that exceeded the 1.5-second limit were located on the 25° azimuth radial.

The data shows that the vast majority of reports of each type fall within the 1.5-second delay limit. Due to inherent inaccuracies in the measurement, the small number of search only reports exceeding the limit is not operationally significant. In addition, if the reinforcement rate had been higher during the test (more representative of real-world conditions), then those RO reports that exceeded the 1.5-second delay requirement would most likely have been reinforced RB reports with a smaller delay.

Run 595 was performed to test the radial capacity of the ARSR-4. A strobe of 60 digital search and 12 beacon targets were injected into the ARSR-4 during the test. The search targets had radial movement of 562.5 knots. The beacon targets were stationary. Therefore, the merge rate varied during the test.

Table 4.1.12-5 shows that at least 60 target reports were output on most of the scans. Twelve beacon reports (RB + BO) were output on each scan. The search reports (RO + RB) per scan varied between 56 and 60 throughout the test. On those scans where less than 60 total target reports were output, the STTG injected less than 60 search test targets due to uneven target movement into and out of the coverage area. The maximum RO report delay during the test was 1.22 seconds. The radial capacity and delay was operationally acceptable.

TABLE 4.1.12-5. RUN 595 TARGET COUNTS PER SCAN

Scan	RO	BO	RB	Total	Scan	RO	BO	RB	Total
1	59	12	0	71	51	50	4	8	62
2	60	12	0	72	52	56	10	2	68
3	47	0	12	59	53	57	12	0	69
4	59	12	0	71	54	58	12	0	70
5	59	12	0	71	55	50	5	7	62
6	60	12	0	72	56	55	10	2	67
7	47	0	12	59	57	57	12	0	69
8	59	12	0	71	58	58	12	0	70
9	59	12	0	71	59	52	6	6	64
10	60	12	0	72	60	56	10	2	68
11	47	0	12	59	61	57	12	0	69
12	59	12	0	71	62	57	12	0	69
13	59	12	0	71	63	53	7	5	65
14	60	12	0	72	64	56	10	2	68
15	47	0	12	59	65	56	11	1	68
16	59	12	0	71	66	58	12	0	70
17	58	12	0	70	67	53	7	5	65
18	60	12	0	72	68	56	10	2	68
19	47	0	12	59	69	54	10	2	66
20	59	12	0	71	70	58	12	0	70
21	59	12	0	71	71	54	8	4	66
22	60	12	0	72	72	56	10	2	68
23	47	0	12	59	73	54	9	3	66
24	59	12	0	71	74	57	12	0	69
25	58	12	0	70	75	53	9	3	65
26	58	12	0	70	76	56	10	2	68
27	47	0	12	59	77	54	9	3	66
28	59	12	0	71	78	58	12	0	70
29	57	12	0	69	79	56	10	2	68
30	58	12	0	70	80	56	10	2	68
31	47	1	11	59	81	54	8	4	66
32	58	11	1	70	82	58	12	0	70
33	58	12	0	70	83	56	10	2	68
34	59	12	0	71	84	56	10	2	68
35	46	1	11	58	85	53	7	5	65
36	56	10	2	68	86	58	12	0	70
37	57	12	0	69	87	57	11	1	69
38	58	12	0	70	88	56	10	2	68
39	49	2	10	61	89	51	6	6	63
40	56	10	2	68	90	58	12	0	70
41	58	12	0	70	91	58	12	0	70
42	58	12	0	70	92	56	10	2	68
43	48	3	9	60	93	51	6	6	63
44	55	10	2	67	94	58	12	0	70
45	58	12	0	70	95	58	12	0	70
46	59	12	0	71	96	56	10	2	68
47	50	4	8	62	97	51	6	6	63
48	57	10	2	69	98	58	12	0	70
49	58	12	0	70	99	58	12	0	70
50	58	12	0	70	100	56	10	2	68

Conclusions

a. DT&E SPQT 16 tests fully exercised the capacity and delay of the ARSR-4 with and without the Mode S in the test configuration. The SPQT 16 tests of large sector peak and small sector peak capacity, and Central Processing Unit (CPU) and Global Random Access Memory (GRAM) reconfiguration under capacity conditions were not tested during OT&E. In addition, tests with the Mode S were not performed at Mt. Laguna.

b. The ARSR-4 can process and provide message outputs for a steady state maximum load of 800 aircraft returns within the primary radar coverage area in the ATCBI configuration. Most of the small number (less than 1 percent) of search targets not available in the output data file were caused by geocensor map attenuation. No beacon reports were dropped.

c. The maximum report delay under scan capacity conditions is acceptable. The small number of search only reports (11) whose delays exceeded the 1.5-second requirement are statistically insignificant.

d. The ARSR-4 can adequately process and provide message outputs for an azimuth peak of 60 aircraft returns aligned in an azimuth radial.

Recommendations

Search, beacon and weather capacity, and delay tests should be repeated for those interfaces not tested during OT&E (Mode S, EARTS, and MicroEARTS). Those tests should include more stringent FRUIT scenarios to test the ARSR-4 beacon target processor capacity.

4.1.13 Weather End-to-End Performance.

Purpose

Verify that the ARSR-4 weather data is accurate and timely.

Test Objectives

a. Verify that the ARSR-4 can detect five levels of weather information corresponding to the standard NWS levels 2 through 6.

b. Verify that the ARSR-4 can output three levels of weather to the ARTCC computers in the proper format.

c. Verify that the ARSR-4 weather processor does not output false weather due to returns from ground clutter during anomalous propagation conditions.

Test Description

Limited tests of the ARSR-4 weather detection and reporting functions were performed with real weather at Mt. Laguna because weather was rarely available in the San Diego area. When weather was present, personnel at the center requested that the ARSR-4 transmitter be turned off because of interference to the ARSR-3 weather processor.

The DT&E General Site Verification (GSV) procedure was repeated during the OT&E regression period. The procedure includes sections on five-level weather processing, three-level weather level processing, weather processing in clutter, and weather averaging and thresholding. All of these tests were performed using ARSR-4 weather test targets.

In addition information was collected through controller questionnaires. ATC observed the display during various environmental conditions including weather, anomalous propagation conditions, and bird activity.

Results

Results of the GSV test indicated that the expected weather levels and positions were displayed on the LDC when the test targets were injected.

During the initial phase of OT&E, a weather reporting problem was identified in the ARSR-4/HOST interface. The ARSR-4 output three levels of weather in the CD data to the ARTCC but the HOST computers could only handle two levels of weather. A HOST software patch configured the ARSR-4 medium and high level weather as high and the ARSR-4 low level weather as low.

Controller evaluation of the system during OT&E retest revealed that the weather information from the HOST was different than the DARC weather information because the three level to two level weather modification had not yet been implemented in DARC.

In addition to weather reporting problems identified, controllers identified times where false weather was being presented on their displays. The source of the false weather was anomalous propagation in the Mt. Laguna area.

Conclusions

a. The ARSR-4 weather detection and reporting capability was not fully evaluated at Mt. Laguna.

b. Limited tests using test targets show that the ARSR-4 weather processor can process and display three or five levels of weather on the LDC at the correct position.

c. The DARC system displays ARSR-4 weather information differently than the HOST does due to the absence of a software patch to convert ARSR-4 three level weather to two level weather. This may cause confusion if the backup system is switched on during times of weather. The inconsistent weather processing between ARTCC computers is not suitable for ATC.

Recommendations

a. Further weather tests should be conducted at another ARSR-4 site where weather is more prevalent. ARSR-4 weather products should be compared to weather products from NWS radars to verify accurate weather reporting.

b. DARC weather processing should be corrected to coincide with the weather processing in NAS so that consistent weather information is reported to the controller when the backup system is switched on-line.

4.1.14 System Control Operation.

The tests in this section measured the ARSR-4 functional and physical interface with the RMS. The ability of the ARSR-4 RMS to reliably provide the means to control and maintain the radar and monitor its performance was tested.

This section is divided into the seven subsections listed below, each describing a different facet of RMS tests.

4.1.14.1	RMS Terminal Operation
4.1.14.2	System Control and Configuration
4.1.14.3	Equipment Performance
4.1.14.4	Alarm Reporting Functions and Fault Isolation
4.1.14.5	Adjustable Parameters
4.1.14.6	Data Extraction
4.1.14.7	Disk Functions

Section 4.1.14.1 describes the tests of the RMS interface to the different system terminals. Sections 4.1.14.2 through 4.1.14.7 each describe a test of functions performed by one of the ARSR-4 RMS menus. Figure 4.1.14-1 shows the ARSR-4 RMS main menu.

```
                 ARSR-4 REMOTE MONITORING SYSTEM FUNCTIONS

1. CONTROL/CONFIGURATION         9. QUICK LOOK

2. PERFORMANCE                  10. LOG OFF

3. ALARM REPORTS                11. BACKUP NON-VOLATILE SAP/FAPS TO PROM

4. FAULT ISOLATION TESTING      12. BACKUP SAFE DATA TO PROM

5. PARAMETERS

6. DATA EXTRACTION

7. DISK FUNCTIONS

8. MAIL
```

FIGURE 4.1.14-1. ARSR-4 MAIN RMS MENU

4.1.14.1 RMS Terminal Operation.

Purpose

Ensure that all RMS functions can be accessed at each local terminal location (LDC/RMS, Maintenance Display Terminal (MDT), and the Transmitter Maintenance Display Terminal (TMDT)).

Test Objectives

a. Verify that all RMS capabilities are available at the LDC, MDT, and TMDT locations.

b. Verify that ARSR-4 system control can be transferred to each terminal without conflicts.

c. Verify that system control is automatically transferred to the MPS upon failure of the terminal with system control.

Test Description

The ARSR-4 was monitored and controlled from each terminal location to verify that all RMS functions could be accessed. Since, by design, only one terminal should have system control at a time, control was transferred between terminals to verify a smooth transfer. In addition, the terminal which had system control, was faulted to verify that control is automatically transferred to MPS.

Data Analysis

System control indications were monitored on the RMS menus to verify that the expected terminal locations had system control. RMS menu information presented at each terminal was compared.

Results

Each terminal can access ARSR-4 software configuration information. Figure 4.1.14.1-1 shows the ARSR-4 configuration information available via the RMS. For each software segment, the current software version number and checksum are available to the user. In addition, access from any terminal location is password protected.

```
          +---------------------------------------------+
                              ARSR-4
                     REMOTE MONITORING SYSTEM
          +---------------------------------------------+

                          FIXED SEGMENTS

CUR    CHK   SYSTEM SEGMENT            CUR   CHK   SYSTEM SEGMENT
VER    SUM                             VER   SUM

__ __  ____  OPERATION CODE            __ __ ____  BIT BCN TRAN TBL PTRS
__ __  ____  SCREENS/MENUS             __ __ ____  BIT BCN TRAN TBL DATA
__ __  ____  FORMATTER DEFINITIONS     __ __ ____  BIT SRCH TRAN TBL PTRS
__ __  ____  NON-VOLATILE SAP/FAPS     __ __ ____  BIT SRCH TRAN TBL DATA
__ __  ____  VOLATILE SAP/FAPS         __ __ ____  FIT TABLES
__ __  ____  CONFIGURATION             __ __ ____  RPLAU
__ __  ____  SAFE DATA                 __ __ ____  ARADES MP CURVES

                ENTER PASSWORD TO LOGIN: ________
```

FIGURE 4.1.14.1-1. ARSR-4 SOFTWARE VERSION/CHECKSUM MENU

Operational parameters are provided for each functional area of the system. This includes: search, beacon, merge, mode 4, weather, antenna, map, user, and general setup parameters.

System performance can be monitored from each terminal location. Beacon, search, and mode 4 processor performance statistics are monitored on a scan-to-scan basis. Transmitter and receiver performance are monitored with readbacks from critical areas within those units. Counts of messages sent to each user are available at each terminal.

ARSR-4 alarm information is sent to each terminal location via the RMS and the functionality exists to run fault isolation tests from each terminal.

Performance parameters are accessible at each terminal location. Some parameters are accessible only when the terminal has system control. This is acceptable since the terminal with system control should be the only terminal with access to these parameters.

During the first phase of OT&E, the MDT was powered off and disconnected from the RCJB while the MDT had system control. This simulated an MDT failure. After reconnection and MDT power up, the MDT was locked out while LDC/RMS indicated that the MDT was in control. A cold start was necessary to force system control to MPS.

Subsequent retests with the 6SEP94 and 25MAY95 software builds in the system could not reproduce the problem. The system responded as expected with system control immediately going to the MPS as the MDT was faulted. In each case, the MDT gave up control in less than 40 seconds.

Throughout OT&E, the reliability of the LDC, and in particular, Video Display Terminal (VDT) in the LDC was poor. The LDC reliability is further discussed in section 4.2.2.

Conclusions
Terminals connected to the LDC, MDT, and TMDT ports operate in a similar manner when monitoring or controlling the system. General terminal operation and function at the LDC location (not considering its reliability) is acceptable.

Full control of the ARSR-4 can be performed at any terminal location at the local site. Transmitter operation, antenna drive control, software initialization, and modes of operation are accessible at each terminal location.

Performance parameters are adequate to provide the operator with the data necessary to verify system health.

Since the same RMS information is available at each terminal location, the MDT can be used as a backup for the unreliable LDC terminal.

4.1.14.2 System Control and Configuration (RMS Menu 1)

Purpose
Ensure that the RMS provides the necessary hardware, software, and control signals to adjust the operational equipment and properly configure parameters to the needs of an unique site.

Test Objectives

a. Verify proper operation of the RMS control and status functions which include: selection of system control location, transmitter control, antenna control, selection of ARSR-4 operating mode, and system reset.

b. Verify proper operation of the RMS system hardware configuration functions which provide status and control of reconfigurable elements (such as beacon channel or synchronizers).

c. Verify that the Interpulse Period (IP) is selectable at the RMS individually for each sector.

d. Verify that the frequency mode is selectable at the RMS individually for each sector.

e. Verify that the polarization is selectable at the RMS individually for each sector.

f. Verify that the RMS correctly reports the status of each terminal as well as the status of the Mode S interface.

g. Verify that the RMS provides transmitter calibration control and status.

Test Description

Functions were exercised on ARSR-4 RMS menu 1, "System Control and Configuration" and its submenus. The system was monitored to ensure that the exercised commands operated as expected.

Figure 4.1.14.2-1 shows ARSR-4 RMS menu 1. The menu is divided into submenus which provide the means to control on-line reconfigurable elements and system operating modes.

```
                    1 SYSTEM CONTROL AND CONFIGURATION

1. CONTROL AND STATUS

2. SYSTEM HARDWARE CONFIGURATION

3. SECTOR CONTROL - IP MODE

4. SECTOR CONTROL - FREQUENCY MODE

5. SECTOR CONTROL - POLARIZATION

6. SITE CONFIGURATION

7. TRANSMITTER RF PORT CALIBRATION VERIFICATION

8. TRANSMITTER RF DETECTOR INPUT POWER
```

FIGURE 4.1.14.2-1. RMS MENU 1 "CONTROL AND CONFIGURATION"

Results

Figure 4.1.14.2-2 shows menu 1.1, "System Status and Control." System control was successfully transferred between terminals. Control automatically returns to MPS when control is released at a terminal. Transmitter and antenna controls operated normally. The system mode controls operated correctly. Warm and cold starts were successfully initiated from the RMS. The transmitter power override function was not tested at Mt. Laguna.

```
                              1.1 SYSTEM CONTROL AND STATUS

CURRENT STATUS >>

CONTROL POINT: __ (LDC, MPS, MDT, TMDT)  ANTENNA DRIVE 1:   __   (ON/OFF)
                                         ANTENNA DRIVE 2:   __   (ON/OFF)
  SYSTEM MODE: __ (OPER, REPR, MANT)
                                         TRANSMITTER:       __   (ON/OFF)
                                         AUTO TX:           __   (ON/OFF)
CONTROL COMMANDS >>

101. TAKE CONTROL       107. TRANSMITTER ON       203. SYSTEM TO MANT MODE
102. RELEASE CONTROL    108. TRANSMITTER OFF      204. SYSTEM TO REPR MODE
                        109. TRANSMITTER POWER    205. SYSTEM TO OPER MODE
103. ANT DRIVE 1 ON          OVERRIDE
104. ANT DRIVE 1 OFF
105. ANT DRIVE 2 ON     201. WARM START SYSTEM    206. ENABLE AUTO TX
106. ANT DRIVE 2 OFF    202. COLD START SYSTEM    207. DISABLE AUTO TX
```

FIGURE 4.1.14.2-2. RMS MENU 1.1 "SYSTEM CONTROL AND STATUS"

On menu 1.2, "System Hardware Configuration," the status and control of hardware elements operated as expected. The RMS provided the capability to reconfigure hardware elements to On-line, Standby, Repair, or Lock status.

On menu 1.3, "Sector Control - IP Mode," selection and status of Second Time around Clutter (STAC) and VIP modes operated correctly. Pulse Agile (PULS) was verified during DT&E and observed to work. However, tests were not repeated during OT&E due to a limited number of transmit frequency pairs available at Mt. Laguna.

On menu 1.5, "Sector Control - Polarization," linear or circular polarization was successfully selected for individual sectors.

On menu 1.6, "Site Configuration," mode 4 parameters operated as expected. LDC, MDT, and TMDT terminal status was correctly reported at this menu. Mode S status was correctly reported on this menu, however, channel configuration status was not verified due to the absence of the Mode S at Mt. Laguna.

On menus 1.7 and 1.8, transmitter RF port calibration verification did not respond correctly. Retest with the 25MAY95 software build produced two issues. First, the calibrate function at menu 1.7 sometimes turns the transmitter RF off when the command is executed. Second, power readings at menus 2.1.1 and 2.14 for lookdown sectors did not clear to zero after the lookdown channel was disabled.

Conclusions
Functions on RMS menus 1.1 through 1.6 operated correctly, providing the ability to effectively configure and control the ARSR-4.

Transmitter functions on menus 1.7 and 1.8 did not operate correctly. The calibrate function should not turn the transmitter RF off. Power readings at menus 2.1.1 and 2.14 should be consistent with the actual status of the ARSR-4 transmitter.

Recommendations
The identified malfunctions on RMS menus 1.7 and 1.8 should be corrected.

4.1.14.3 Equipment Performance (RMS Menu 2)

Purpose
Ensure that the RMS monitors ARSR-4 performance and accurately reports data to the user.

Test Objective
Verify that the RMS reports accurate performance information via menu 2, "Equipment Performance" to ensure the system is operating within certified limits.

Test Description
Functions were exercised on ARSR-4 RMS menu 2, "Equipment Performance" and its submenus. The system was monitored to ensure that the exercised commands operated as expected and that accurate information was presented to the user.

Figure 4.1.14.3-1 shows RMS menu 2. The menu is divided into categories which provide performance data for the transmitter and receiver as well as scan statistics and test target generation.

```
                         2 EQUIPMENT PERFORMANCE

 1. TRANSMITTER                        12. ATCBI PERFORMANCE
 2. RECEIVER                           13. HEIGHT CALIBRATION PERFORMANCE
 3. CLUTTER CANCELLATION               14. CERTIFICATION
 4. SCAN STATISTICS
 5. DATA COUNT MONITOR

 6. SPECTRUM ANALYSIS
 7. CALIBRATION SERVO CONTROL

 8. SEARCH TEST TARGET GENERATION
 9. BEACON TEST TARGET GENERATION

10. DISCRETE VIDEOS
11. A-SCOPE VIDEO
```

FIGURE 4.1.14.3-1. RMS MENU 2 "EQUIPMENT PERFORMANCE"

Data Analysis
RMS performance data was compared with the actual state of the ARSR-4 or with recorded data to verify the correctness of the data.

Results
On Menu 2.1, "Transmitter Performance," transmitter output power, Voltage Standing Wave Ratio (VSWR), and collector power supply bus voltage data was accurately reported for the Lookdown, A, and B channels. Beam Steering statistics and control were adequate.

On Menu 2.2, "Receiver performance" Low Noise Amplifier (LNA) gain and phase and Minimum Discernible Signal (MDS) values are provided for each beam and frequency.

Menu 2.3, "Clutter Cancellation," provides Moving Target Indicator (MTI) Improvement Factor and Subclutter Visibility information for a selected area of clutter.

On Menu 2.4, "Scan statistics," accurate statistics for each major functional unit are provided. Areas monitored include: Search Target Extractor Inputs/Outputs, First and Second Function Scan-to-Scan Correlator, Beacon Target Detector, Radar/Beacon Reinforcement, and Editor and Formatter statistics.

On Menu 2.5, "Data Count Monitor," numbers are accurately compiled over a user selectable data count interval.

On menu 2.6, "Spectrum Analysis," was successfully performed on a target of opportunity.

On menu 2.7, "Calibration Servo Control," automatic adjustments to the ARSR-4 perform normally.

On menu 2.8, "Search Test Target Generation," all test target scenarios operated correctly (including the Continuous Wave (CW) test parameters).

On Menu 2.9, "Beacon Operational Test Targets," functions operated properly. At menu 2.9.2, however, test targets were not visible on the LDC for any test target scenario.

Menu 2.10, 2.11, and 2.13 functions were not tested during local RMS interface testing.

On Menu 2.12, "ATCBI Performance," the beacon status and performance information was accurate.

On Menu 2.14, "Certification," loss of redundancy, RTQC, alarms, transmitter power and VSWR, and receiver MDS data are accurately presented. Figures 4.1.14.3-2 and 4.1.14.3-3 show the certification menus. These menus were used to certify the ARSR-4 for ATC after OT&E was completed.

```
                     2.14 CERTIFICATION        PAGE 1 OF 2

CURRENT DATE AND TIME: _______

CRITICAL ALARMS PRESENT: _____  (0 = NO, 1 = YES)
LOSS OF REDUNDANCY:          _  (0 = NO, 1 = YES)

BEACON RTQC RANGE:    _____ NMI      SEARCH RTQC RANGE:   ____  NMI
BEACON RTQC CENTER    _____ IACPS    SEARCH RTQC CENTER:  ____  iACPs
BEACON RTQC AZIMUTH   _____ ACPS     SEARCH RTQC AZIMUTH: ____  ACPs
BEACON RTQC ALARM     _____

AVE XMITTER PWR CH A: _____ dBw   60 uSEC IMPROVEMENT FACTOR: _____  dB
AVE XMITTER PWR CH B: _____ dBw   90 uSEC IMPROVEMENT FACTOR: _____  dB
AVE XMITTER PWR LOOKDOWN: _____ dBw

60 uS VSWR CH A:        _______   90 uS VSWR CH A:        _______
60 uS VSWR CH B:        _______   90 uS VSWR CH B:        _______
60 uS VSWR CH LOOKDOWN: _______   90 uS VSWR CH LOOKDOWN: _______
```

FIGURE 4.1.14.3-2. CERTIFICATION MENU - PAGE 1

```
2.14 CERTIFICATION        PAGE 2 OF 2

CURRENT DATE AND TIME: _______

BEAM  ROW   MDS F1 LP       MDS F2 LP
 LD    2    ________ dB    ________ dB
  1    8    ________ dB    ________ dB
  2    9    ________ dB    ________ dB
  3   10    ________ dB    ________ dB
  4   11    ________ dB    ________ dB
  5   13    ________ dB    ________ dB
  6   14    ________ dB    ________ dB
  7   16    ________ dB    ________ dB
  8   18    ________ dB    ________ dB
  9   21    ________ dB    ________ dB
```

FIGURE 4.1.14.3-3. CERTIFICATION MENU - PAGE 2

Conclusions

a. ARSR-4 performance monitoring accurately reflected the health of the transmitter and receiver.

b. "Scan Statistics" and "Data Count" menus provided accurate ARSR-4 performance information.

c. The "Certification" menu provided sufficient information to certify the use of the ARSR-4 in NAS.

4.1.14.4 Alarm Reporting Functions (RMS Menu 3) and Fault Isolation (RMS Menu 4)

Purpose

Ensure that ARSR-4 BIT reports any radar malfunction promptly and that FIT provides sufficient information to the maintenance technician to locate and replace the faulted equipment.

Test Objectives

a. Verify that the ARSR-4 detects injected faults and accurately reports the alarm status on RMS menu 3, "Alarm Reports."

b. Verify that FIT correctly isolates at least 99.9 percent of all detected failure faults to a group of no greater than eight Logical Replaceable Units (LRUs).

c. Verify that BIT reports the results of fault isolation to the RMS after completion of the automatic diagnostic process.

Test Description

Tests of ARSR-4 BIT and FIT operation were performed at the same time. Faults were injected into the ARSR-4 to verify menu 3 and menu 4 functions. The system was monitored to ensure that the expected alarms were reported by BIT. FIT was then exercised on the faulted subsystem to verify that the correct LRU was isolated. Figure 4.1.14.4-1 shows RMS menu 3. BIT is provided for all major subassemblies and most LRUs. When an alarm appears on this menu, further investigation is done by traversing downward through the RMS BIT submenus.

```
                              3 ALARM REPORTS

1. PEDESTAL/RADOME          ___       8. DET CHAN 1          ___
                                      9. DET CHAN 2          ___
2. TRANSMITTER              ___      10. DET CHAN 3          ___
                                     11. DET CHAN 4          ___
3. ANT/RF/IF RECEIVERS      ___      12. DET CHAN 5          ___
                                     13. DET CHAN 6          ___
4. FREQ GEN                 ___      14. DET CHAN 7          ___

5. SIGNAL PROC MISC.        ___      15. DATA PROCESSOR      ___
                                     16. WEATHER STATION     ___
6. SYNC/MAP A               ___      17. BEACON/MODE 4 A     ___
7. SYNC/MAP B               ___      18. BEACON/MODE 4 B     ___
                   19. SOFTWARE PERFORMANCE ___
```

FIGURE 4.1.14.4-1. RMS MENU 3 - ALARM REPORTS

Figure 4.1.14.4-2 shows RMS menu 4. The menu is very similar in appearance to menu 3. By design, after an alarm is indicated on menu 3, further diagnostic tests for the alarmed subsystem can be commanded on menu 4.

```
                         4 FAULT ISOLATION TESTS

1. PEDESTAL/RADOME                        7. DET CHAN 1
                                          8. DET CHAN 2
2. TRANSMITTER                            9. DET CHAN 3
                                         10. DET CHAN 4
3. ANT/RF/IF RECEIVERS                   11. DET CHAN 5
                                         12. DET CHAN 6
4. FREQ GEN                              13. DET CHAN 7
5. SYNC/MAP A                            14. DATA PROCESSOR
6. SYNC/MAP B                            15. WEATHER STATION
                                         16. BEACON/MODE 4 A
                                         17. BEACON/MODE 4 B
```

FIGURE 4.1.14.4-2. RMS MENU 4 - FAULT ISOLATION TESTS

The function of every alarm was not exercised during OT&E. It was impossible to produce all fault combinations to test all BIT functions. Alarm threshold values were adjusted to induce hard and soft alarms. In addition, a subset of alarms in each major unit was tested by faulting an LRU and observing menu 3 for an alarm indication.

Hardware faults were usually introduced by removing a board from the system, disconnecting cables, or faulting individual chips on a board.

Data Analysis

After each fault was injected into the ARSR-4, RMS menu 3 was monitored to verify that the correct hard or soft alarm indication was displayed. Also, alarm status (as indicated by cabinet lights) was compared to the alarm status presented on the RMS menus. FIT results were compared to expected results.

Results

On menu 3.1, "Pedestal/Radome," thresholds were changed to induce soft and hard alarms for the Azimuth Pulse Generator (APG) and Pedestal Enclosure power supplies and Motor A and B Current. In each case, BIT reported the correct alarm and FIT isolated the correct LRU.

Table 4.1.14.4-1 shows the results of performing BIT/FIT when faults were injected in the Pedestal/Radome. In each case, BIT and FIT correctly identified and isolated the injected fault.

TABLE 4.1.14.4-1. "PEDESTAL/RADOME" BIT/FIT TEST RESULTS

Test No.	Unit/LRU faulted	Fault Method	BIT Result	FIT Result
1	Interlock	Enabled "Rotation Interlock Bypass Switch"	Passed	Passed
2	Oil Level Sensor	Removed Sensor	Passed	Passed
3	Servo Amplifier	Removed cable at 13A2A4J2	Passed	Passed
4	Pedestal Control Cab	Placed local/remote switch to local	Passed	Passed

On menu 3.2, "Transmitter," thresholds were adjusted to induce power supply, VSWR, average and peak power, and transistor count alarms in the transmitter. In each case, BIT returned the correct soft or hard alarm indication and FIT isolated the correct LRU.

Table 4.1.14.4-2 shows the results of performing BIT/FIT when faults were injected in the Transmitter. In each case, BIT and FIT correctly identified and isolated the injected fault. The fault injection methods shown in the table were recommended by WEC.

TABLE 4.1.14.4-2. "TRANSMITTER" BIT/FIT TEST RESULTS

Test No.	Unit/LRU faulted	Fault Method	BIT Result	FIT Result
1	Preamp Switch	Removed J32 near preamp 3	Passed	Passed
2	Pulse Shape Sequencer	Pulled pin 3 high on U76	Passed	Passed
		Grounded TP68	Passed	Passed
		Grounded pin 9 on U69	Passed	Passed
		Removed U56	Passed	Passed
3	RMS Interface	Removed board	Passed	Passed
4	Loop Controller	Grounded TP54	Passed	Passed
		Removed Z7	Passed	Passed

On menu 3.3, "Ant/RF/Intermediate Frequency (IF) Receivers," thresholds were adjusted to induce ANT/RF/IF power supply and LNA Gain and Phase alarms. In each case, BIT returned the correct soft or hard alarm indication and FIT isolated the correct LRU. Table 4.1.14.4-3 shows that BIT and FIT worked properly for the cabinet blowers and Receiver Interface board.

TABLE 4.1.14.4-3. "ANT/RF/IF RECEIVERS" BIT/FIT TEST RESULTS

Test No.	Unit/LRU faulted	Fault Method	BIT Result	FIT Result
1	Cabinet Blowers	Turned off IF receiver cabinet blowers	Passed	Passed
2	Receiver Interface	Removed board	Passed	Passed

On menu 3.4, "Freq Gen," thresholds were adjusted to induce RF test target level alarms. BIT reported the correct results and FIT isolated the correct LRUs.

Table 4.1.14.4-4 shows that BIT/FIT worked effectively in identifying and isolating faults in the Frequency Generator.

TABLE 4.1.14.4-4. "FREQ GEN" BIT/FIT TEST RESULTS

Test No.	Unit/LRU faulted	Fault Method	BIT Result	FIT Result
1	Oscillator	Removed cable at J2	Passed	Passed
2	Stalo Generator	Removed cable at J6	Passed	Passed
3	COHO Generator	Shorted two pins on U114	Passed	Passed
4	Transmit Generator	Removed cable at J2	Passed	Passed
5	Waveform Generator	Grounded pin 78 on RRWDS board	Passed	Passed

On menu 3.5, "Signal Processor Misc.," thresholds were adjusted to induce Signal Processor power supply alarms and blowers were turned off to exercise blower alarms. BIT and FIT reported correct results in each case. WEC recommended fault injection techniques produced the correct "Sync/Map" BIT/FIT results as shown in table 4.1.14.4-5.

TABLE 4.1.14.4-5. "SYNC/MAP" BIT/FIT TEST RESULTS

Test No.	Unit/LRU faulted	Fault Method	BIT Result	FIT Result
1	Radar Control	Removed board	Passed	Passed
2	Radar Triggers	Inserted faulty chip U62	Passed	Passed
		Removed U1	Passed	Passed
3	Search TTG	Inserted faulty chip U136	Passed	Passed
4	Frequency Select	Pulled pin 19 high on U22	Passed	Passed
		Removed U46	Passed	Passed
5	Clutter Map	Removed Board	Passed	Passed
6	Detection Map	Removed Board	Passed	Passed
7	Filter Select	Removed Board	Passed	Passed
8	Map Control	Grounded TP43	Passed	Passed
9	RRWDS	Removed U113 chip	Passed	Passed
		Grounded TP34	Passed	Passed

During the first OT&E phase, "Det Chan 1" was faulted by removing the Pulse Compressor board. Nineteen minutes elapsed before alarms in the pulse compressor alarm group were observed at RMS. The BIT reporting time was excessive. Retest using a WEC recommended fault injection technique produced the BIT alarm in 6 minutes. FIT correctly isolated Detection Channel 1. Table 4.1.14.4-6 shows the retest results for "Det Chan" BIT/FIT. All tests were successful.

TABLE 4.1.14.4-6. "DET CHAN" BIT/FIT TEST RESULTS

Test No.	Unit/LRU faulted	Fault Method	BIT Result	FIT Result
1	Pulse Compressor	Removed U85	Passed	Passed
2	Doppler Filter	Inserted faulty chip U27	Passed	Passed
4	Channel Interface	Grounded pin 3 of U62	Passed	Passed
5	CFAR	Inserted faulty chip U18	Passed	Passed

On menu 3.15, "Data Processor," thresholds were adjusted to induce Data Processor power supply alarms. BIT/FIT worked accurately in detecting and isolating the faults. Table 4.1.14.4-7 shows that BIT/FIT tests on the Data Processor produced acceptable results.

TABLE 4.1.14.4-7. "DATA PROCESSOR" BIT/FIT TEST RESULTS

Test No.	Unit/LRU faulted	Fault Method	BIT Result	FIT Result
1	CPUs	Removed CPU boards 1,3,9	Passed	Passed
2	DP Blowers	Toggled blower power	Passed	Passed
3	GPROM	Removed board	Passed	Passed
4	Mode 4 Safe	Opened Safe door	Passed	Passed
5	RDR Display Interface	Removed "RAPPI IN" cable	Passed	Passed
6	BCN Display Interface	Removed board	Passed	Passed
7	SIOs	Removed Modem Cables	Passed	Passed

The GRAM, Bus Receiver (BRX), Radar Interface (RIB), PMS/488/Disk, and Bus Extender (BTX) boards could not be removed from the Data Processor without locking up the system. Therefore, BIT/FIT tests for these boards were not performed.

Individual alarms were not verified on menu 3.16, "Weather Station," however, the weather station was faulted to exercise bits in the SOCC status message. The results of these tests are included in section 4.1.4 of this report.

The "Beacon/Mode 4" BIT/FIT tests and results are shown in table 4.1.14.4-8. BIT/FIT operated effectively when each board was removed.

One serious problem, not identified during a formal test of BIT/FIT, is described below.

In April 1995, start of the regression phase of OT&E was delayed due to the overall instability of the ARSR-4. Symptoms included:

a. frequent beacon RTQC "dropouts," where the injected target was processed and reported outside the expected RTQC azimuth window and not properly tagged as an RTQC,

b. an instance of all reported beacon targets being offset by 30° from their true azimuth,

c. two occasions where all beacon reports were reported along one azimuth for one scan.

TABLE 4.1.14.4-8. "BEACON/MODE 4" BIT/FIT TEST RESULTS

Test No.	Unit/LRU faulted	Fault Method	BIT Result	FIT Result
1	BCN Video Quantizer	Removed board	Passed	Passed
2	BCN Code Extractor	Removed board	Passed	Passed
3	BCN CTRL and TTG	Removed board	Passed	Passed
4	M4 Defruiter	Removed board	Passed	Passed
5	M4 CTRL	Removed board	Passed	Passed
6	M4 Reply Proc	Removed board	Passed	Passed
7	BCN Defruiter	Removed board	Passed	Passed

In each case, BIT failed to report a hard alarm and FIT did not isolate the problem. Further troubleshooting with specialized debug equipment revealed that four faulty boards (one Beacon Code Extractor (BCE), one BTX, and two RIBs) had contributed to these problems. Changes were later made to make the BIT tests for the RIB and BCE board more sensitive. However, no improvements were made to BTX BIT operation.

Conclusions

a. BIT (menu 3) and FIT (menu 4) test all major functional areas of the ARSR-4.

b. BIT responded with correct results when thresholds were adjusted to induce faults in the system.

c. The board removal fault injection techniques often do not simulate real-world failures of LRUs. On the other hand, the extent to which Westinghouse recommended fault injection techniques simulate real-world failures is unknown.

d. The case of four faulty boards being removed from the system without an alarm shows that ARSR-4 BIT/FIT cannot detect all possible failures of LRUs in the system.

Recommendations

BIT and FIT should not be used as the sole means for system maintainability. Maintenance procedures (e.g., flowcharts) should be developed to supplement the automatic BIT and FIT functions in the radar. These procedures can be developed based on the existing ARSR-4 design and updated as more failure data is available from the field.

4.1.14.5 Adjustable Parameters (RMS Menu 5)

Purpose

Ensure that RMS adjustable parameters provide enough flexibility and functionality to optimize the system.

Test Objectives

a. Verify that sufficient functionality exists in the ARSR-4 parameters to adjust the radar's performance.

b. Verify that parameter changes change system performance as expected.

Test Description

Commands were exercised on ARSR-4 RMS menu 5, "System Operational Parameters" and its submenus. The system was monitored to ensure that the commands operated as expected.

Figure 4.1.14.5-1 shows menu 5. Site and field adjustable parameters, operational, and adaptation parameters were verified by changing parameter values in the 10 major operational areas at menu 5. The system must accept parameter values within specified limits and reject out-of-tolerance values. Note that not all of the parameter changes made an obvious change to the system. Therefore, the effectiveness of those parameters were not verified.

```
                    5 SYSTEM OPERATIONAL PARAMETERS

1. ANTENNA                       9. GENERAL SETUP

2. SEARCH PROCESSING            10. MPS SETUP

3. BEACON PROCESSING

4. MERGE PROCESSING

5. MODE 4 PROCESSING

6. FORMATTER / I/O SERVICES

7. MAPS

8. WEATHER PROCESSING
```

FIGURE 4.1.14.5-1. RMS MENU 5 - SYSTEM OPERATIONAL PARAMETERS

Data Analysis

By monitoring alarms, status, LDC video, and equipment performance, the effect of parameter changes were confirmed.

Results

On menu 5.1, "Antenna," azimuth offset parameters and test target cable loss parameters operated normally.

On menu 5.2, "Search Processing," most parameters were successfully verified. The RMS allowed entry of all expected values during parameter changes. The entries ranged from minimum to maximum values for each parameter. However, the functional effect of many of the parameter changes was not easily noticed. Those areas where changes produced noticeable effects included the transmitter blanking sectors, search and weather STC, geocensor range extent, search RTQC, and track state minimum eligibility factors.

One adverse effect was noticed during setup of permanent echo zones on menu 5.2.3. Although the parameters could be successfully changed, the ARSR-4 only intermittently outputs the permanent echo because of filtering in the search processor.

On menu 5.3, "Beacon Processing," beacon detection, runlength discrimination, beacon tolerance, and beacon RTQC parameters were verified through data collection and analysis to operate effectively. There was no test performed with different beacon PRFs.

On menu 5.4, "Merge Processing," values in merge processing were accepted by the system and out-of-range values were prohibited. The range and azimuth parameters at menu 5.4.2 were changed and performance changes were seen on the RAPPI and performance menus. No obvious change in scan-to-scan statistics, system performance, or LDC video could be observed for any other parameter in menu 5.4.

On menu 5.5, "Mode 4 Processing," only the sector transmission inhibits parameters were tested. Inhibit zones were properly displayed on the LDC RAPPI when these parameters were exercised. The remaining functions of menu 5.5 were tested by the USAF.

On menu 5.6, "Formatter/IO Services," parameters were successfully entered and accepted by the RMS.

On menu 5.7, Map parameters were successfully exercised during the site optimization when geocensor, clear day, and land/sea maps were developed.

On Menu 5.8, "Weather Processing," all parameter changes were accepted by the RMS. However, the functional effects of some of the changes (including adjustment of minimum weather hole and vector sizes) were not seen in ARSR-4 operation.

On menu 5.9, "General Setup," parameters were verified to the extent that this site permitted. No Mode S was present at the site and the Radar Beacon Performance Monitor (RBPM) interface

was not functioning at the time of testing. Other site parameters were tested as normal site optimization procedures were performed.

On menu 5.10, "MPS Setup," the Link Address and SAP Override parameters operated as expected.

Conclusions

The ARSR-4 parameters provide adjustments for the major functional areas of the system. Not every parameter was exercised, however, the parameters appear to be adequate to: adapt each site to local conditions; optimize search, beacon, mode 4, and weather processing; and configure data transmission to up to 20 different users.

Discussions with personnel at the Los Angeles ARTCC reveal that the ARSR-4's inability to consistently output a search permanent echo is not an operational problem.

4.1.14.6 Data Extraction (RMS Menu 6).

Purpose

Ensure that the data extraction subsystem is capable of extracting data from the operating system in real-time and recording that data for subsequent off-line reduction and analysis.

Test Objective

a. Verify that data can be extracted from each location identified in RMS menu 6.1.

b. Verify that data extraction has no adverse impact on the normal operation of the radar.

Test Description

Data was extracted from different points in the ARSR-4 during the test. Figure 4.1.14.6-1 shows RMS menu 6. The menu allows for initiation of up to four simultaneous data extractions. The extractions can be set up for a user designated number of scans or can be allowed to extract continuously. The status of the completed scans for each session and the remaining disk space available are displayed on menu 6.

Figure 4.1.14.6-2 shows the data extraction categories available. Each category of extraction was exercised and a confirmation of sufficient recording capacity was also tested.

```
                          6 DATA EXTRACTION

                                                                _______
    ITEM          SESSION 1       SESSION 2      SESSION 3     SESSION 4

    ID            _______         _______        _______       _______
    CATEGORY      _______         _______        _______       _______
    START         __:__:__        __:__:__       __:__:__      __:__:__
    STATUS        ________        ________       ________      ________
    SCANS COMPL   ___ ___         ___ ___        ___ ___       ___ ___

                  1.ENTER DATA  2.ENTER DATA  3.ENTER DATA  4.ENTER DATA
92. ENABLE ALL   12.ENABLE     22.ENABLE     32.ENABLE     42.ENABLE
93. DISABLE ALL  13.DISABLE    23.DISABLE    33.DISABLE    43.DISABLE
94. LOAD ALL
95. CANCEL ALL

          _______  KBYTES FREE
```

FIGURE 4.1.14.6-1. RMS MENU 6 - DATA EXTRACTION SETUP

```
                         6.1 EXTRACTION TYPE

SESSION: 1

   1. PULSE COMPRESSOR I/O          6. HARDWARE MAPS

   2. LOG AMPLITUDE                 7. SOFTWARE MAPS

   3. INPUTS TO SURVEILLANCE        8. RADAR CONTROL

   4. SURVEILLANCE PROCESSING

   5. FORMATTER AND I/O SERVICES
```

FIGURE 4.1.14.6-2. RMS MENU 6.1 - DATA EXTRACTION TYPES

Results

Several data extraction problems were noted during OT&E.

a. During the first OT&E phase, a four-session data extraction was attempted while the ARSR-4 had low target loading and no relevant alarms. The hardware extraction session stopped. Retest on July 3, 1995, resulted in the hardware extraction session again stopping. Two additional trials had the same result. The problem only affected hardware data extractions. All other extraction types operated normally. There were no adverse effects on normal ARSR-4 operation.

b. During the first OT&E phase, a hardware extraction caused loss of redundancy and critical alarms in the ARSR-4. A cold start was necessary to return the system to normal operation. Retests on June 22, 1995, June 27,1995, and July 1, 1995, could not duplicate the problem. The system responded normally in each case. Software changes in data extraction units are likely to have corrected the original problem.

Conclusions

Data extraction, menu 6, provides a basic method to record target data at selected processing points in the ARSR-4 system.

All data extraction types (except hardware extractions) were executed reliably from the RMS with no adverse impact to normal ARSR-4 operation.

Hardware data extraction sessions often terminate prematurely. Those failure modes where hardware extractions caused anomalies in normal ARSR-4 operation could not be reproduced during OT&E regression tests with the 25MAY95 software build in the system.

Recommendations

Data extraction functions should be exercised on each new ARSR-4 software build to ensure that the extractions do not impact normal system operation and operate correctly.

4.1.14.7 Disk Functions (RMS Menu 7).

Purpose

Verify that complete hard disk operations can be performed by displaying software segments, listing and deleting files, storing and loading SAP/FAPs and Configuration to/from hard disk.

Test Objectives

Verify that the functions on ARSR-4 RMS menu 7, "Disk Functions" operate correctly.

Test Description

Functions were exercised on ARSR-4 RMS menu 7, "Disk Operations." The system was monitored to ensure that the exercised commands operated as expected.

Figure 4.1.14.7-1 shows RMS menu 7. The menu contains options which allow for basic disk maintenance and access to software configuration segments.

Results

The list/delete files functions at menu 7.1 performed as expected.

Software segment version numbers are displayed at menu 7.2. Checksums for the current software version are also displayed. Loading software segments from disk to Random Access Memory (RAM) performed normally.

Parameter and Configuration segments, menu 7.3, operated as expected.

```
                         7 DISK OPERATIONS

ENTER PATH FOR DIRECTORY DISPLAY:                PAGE NUMBER:

      C:\ ________________                          __

1. LIST/DELETE FILES

2. SYSTEM SEGMENTS

3. PARAMETER AND CONFIGURATION SEGMENTS

4. MOUNT DISK

5. PARK DISK
```

FIGURE 4.1.14.7-1. RMS MENU 7 - DISK OPERATIONS

Conclusions

Menu 7, "Disk Operations," provides the user with an adequate method to view, delete, and manage files on the system hard disk.

Software modules (segments) can be loaded into the system in the event of a change, update, or failure of any portion of the operating code.

Provisions to remove and reinstall the hard disk work adequately.

4.1.15 Remote Maintenance Monitoring.

Purpose

Ensure that the remote monitoring subsystem of the ARSR-4 provides sufficient information to allow fault isolation and system certification from a remote location.

Test Objectives

a. Verify that the ARSR-4 RMS is fail-safe and does not disrupt any radar functions.

b. Verify that RMS failure alarms and diagnostics are made available to the MPS via RMMS.

c. Verify that the ARSR-4 RMS functions as an integrated component of the RMMS.

Test Description

This section describes the results of the NAS OT&E Integration retest of the ARSR-4 RMS. The initial NAS OT&E Integration test was performed December 19, 1994, through February 13, 1995.

Retest was performed from June 5, 1995, through June 15, 1995, using the ARSR-4 RMS located at Mt. Laguna, CA, and the MPS at the ARTCC in Palmdale, CA. The ARSR-4 RMS software version used during testing was the May 25, 1995 build. The ARTCC MPS, using TANDEM

operating system version C30.07, was running version R08.1 of the Interim Monitor and Control Software (IMCS), through a separate PATHWAY. An LM-1 protocol analyzer, version 8.0 and the enhanced MPS simulator, version 1.01 were used as test tools.

ARSR-4 to MPS interface tests were conducted by the Communication/Infrastructure Branch, ACT-330, at the Technical Center. BIT/FIT verification and limited fault injection were conducted to verify that the remote user had the capability to control the system and received correct status information.

Results

The NAS OT&E Integration retest closed 5 of the 17 previously open Test Trouble Reports (TTRs) and identified 57 new problems. Seventeen of the new TTRs were subsequently closed during the retest period.

Four of the remaining open TTRs were classified as "critical." TTR-018-R1 identified a Global Status command that causes the system to terminate operation. TTR-019-R1 identified a Specific Poll to Logical Unit 3C that causes the system to terminate operation. TTR-022-R1 identified a problem with IMCS in which any commands above data point 4E in any commandable Logical Unit are not accessible. TTR-070-R1 identified a condition where IMCS will become inoperable when an "ALL COMMAND" request is attempted. Of the remaining TTRs, 12 were classified as "major," 16 were classified as "minor," 18 were classified as "annoyance," and 2 were classified as "other."

Additional RMMS tests were performed on the ARSR-4 after the OT&E retest period described in this report. Therefore, more detailed information can be found in the ACT-330 final report on the interface.

Recommendations

a. ACT-330 does not recommend deployment of the ARSR-4 RMS and the IMCS decoder until all critical and major TTRs have been corrected and validated during a retest.

b. ACT-330 also recommends correcting all the minor problems and addressing the annoyances.

4.1.16 ARSR-4 vs. ARSR-3 Comparison.

Purpose

The purpose of this test was to compare the performance of the ARSR-4 with the performance of the existing radar at Mt. Laguna, the ARSR-3. Comparison is made to ensure that no capability is lost with the introduction of the ARSR-4 into NAS.

Test Objective

Verify that the ARSR-4 meets or exceeds the performance of the ARSR-3 while meeting established certification thresholds.

Test Description

Targets of opportunity from the ARSR-4 and the ARSR-3 were simultaneously recorded at the Los Angeles ARTCC HOST during OT&E regression tests. The ARSR-4 was configured into VIP mode for all of the tests. The ARSR-3 was operating in simplex.

The ARSR-3 operated in simplex mode during OT&E (because of mutual interference with the ARSR-4). When operated in simplex mode, the ARSR-3 cannot pass some of the QARS tests with the diplex thresholds. A waiver was made to use ARSR-1/2 (less stringent) tolerances during the OT&E to allow certification of the ARSR-3.

Data Analysis

HOST QARS was performed to evaluate system performance. QARS was performed on the following dates: June 14, 15, 16, 19-23, 26-29; July 7, 10-13, 18-20, 26, 31; August 1-4, 7, 1995. The QARS thresholds established for the ARSR-3 operating in diplex mode were used as a measure of success for this test.

It should be noted that the blanked areas for the ARSR-4 and ARSR-3 may be cause for some of the differences in performance. Blanking was necessary to avoid mutual radar interference. The ARSR-4 transmitter was blanked from 326° to 360° in azimuth. The ARSR-3 transmitter was blanked between approximately 160° and 180°.

Results

Tabular results of QARS analysis on ARSR-4 and ARSR-3 data are included in appendix C. The most stringent QARS fail thresholds were chosen for inclusion in appendix C because the ARSR-4 should be able to meet or exceed those thresholds established for ARSR-3 diplex operation.

Figures 4.1.16-1 through 4.1.16-9 show the ARSR-4 and ARSR-3 results for several of the QARS measured parameters. Results are plotted in a histogram format with the ARSR-4 and ARSR-3 results presented side by side. Note that every other day was scaled on the x-axis of each plot in order to improve the clarity of presentation.

The results of beacon blip scan analysis are shown in figure 4.1.16-1. The results show comparable performance with both radars, with ARSR-4 results slightly better than ARSR-3 results on most days. Both radars consistently exceeded QARS beacon blip scan threshold.

Search blip scan results are shown in figure 4.1.16-2. The ARSR-3 shows low detection due to simplex operation. The ARSR-4 search blip scan compares favorably with the QARS threshold (85 percent). ARSR-4 results were above 92 percent for all days.

Reinforcement results are shown in figure 4.1.16-3. The effects of simplex operation are again seen in the low ARSR-3 reinforcement rate. The ARSR-4 reinforcement rate was consistently above 92 percent (well above the QARS 85 percent threshold).

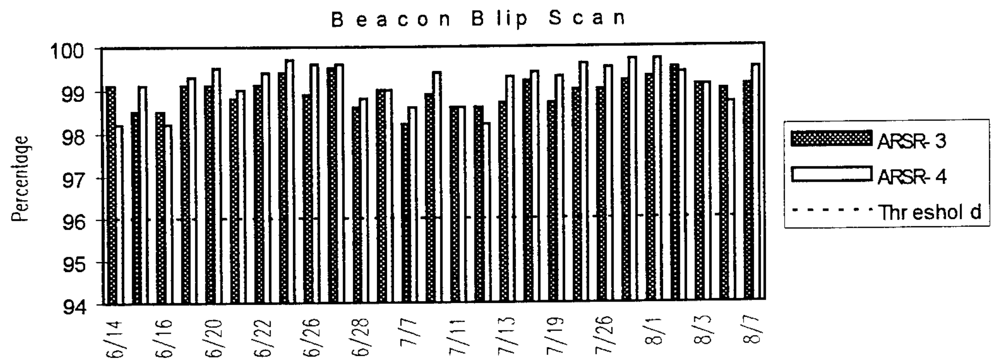

FIGURE 4.1.16-1. ARSR-4 AND ARSR-3 BEACON BLIP SCAN RESULTS

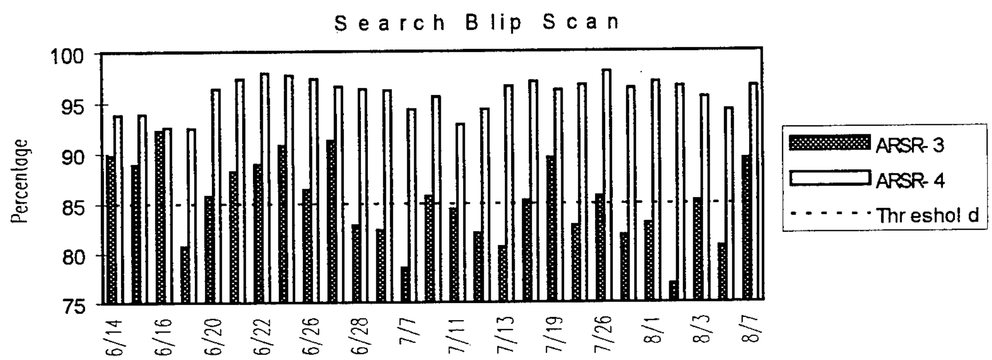

FIGURE 4.1.16-2. ARSR-4 AND ARSR-3 SEARCH BLIP SCAN RESULTS

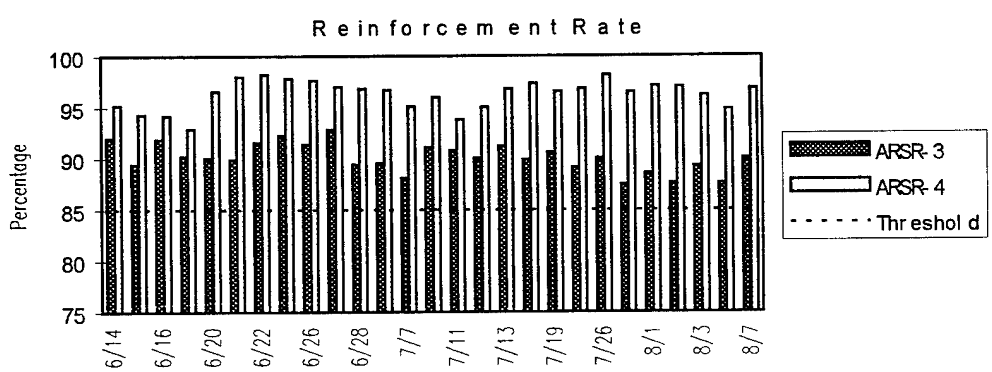

FIGURE 4.1.16-3. ARSR-4 AND ARSR-3 REINFORCEMENT RATE RESULTS

Figure 4.1.16-4 shows results of QARS beacon azimuth split analysis. (Note: The y-axis in the plot was scaled with negative values for data presentation purposes. There is no chance for negative split percentages.) The ARSR-3 split rate remained at 0 percent throughout the test period. On the other hand, the ARSR-4 showed varying azimuth split percentages. Note that in many instances, the ARSR-4 beacon azimuth split rate exceeded the QARS threshold (0.1 percent).

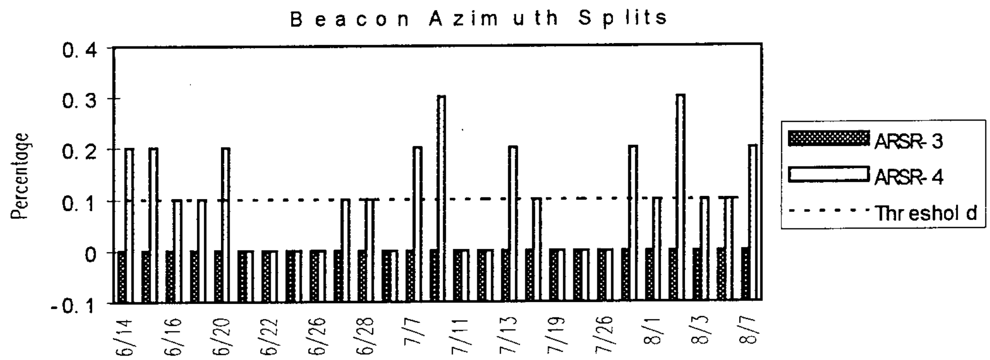

FIGURE 4.1.16-4. ARSR-4 AND ARSR-3 BEACON AZIMUTH SPLIT RESULTS

Figure 4.1.16-5 shows results of QARS beacon range split analysis. The ARSR-3 split rate remained at 0 percent throughout the test period except on July 10, 1995, when the QARS threshold (0.1 percent) was exceeded. On several days, the ARSR-4 split rate was greater than the ARSR-3 rate. The ARSR-4 beacon range split rate reached the QARS threshold on several days and exceeded it on 2 different days.

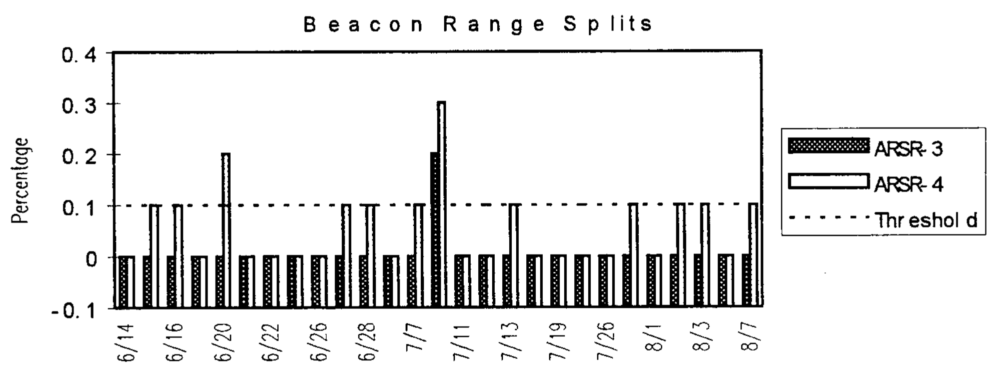

FIGURE 4.1.16-5. ARSR-4 AND ARSR-3 BEACON RANGE SPLIT RESULTS

Mode 3/A Reliability results are displayed in figure 4.1.16-6. Performance is comparable between the two radars. Each radar shows results well above the QARS threshold (96 percent).

Mode 3/A Validation results are displayed in figure 4.1.16-7. On most days, the ARSR-3 performed slightly better than the ARSR-4; however, on each day both radars met or exceeded the QARS threshold (98 percent).

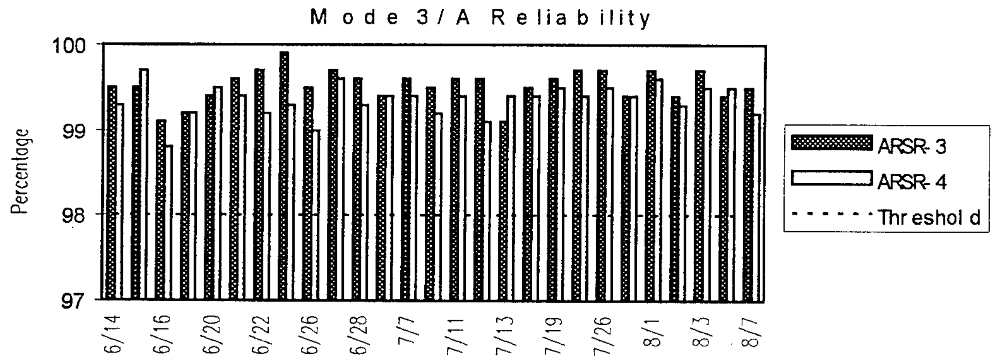

FIGURE 4.1.16-6. ARSR-4 AND ARSR-3 MODE 3/A RELIABILITY RESULTS

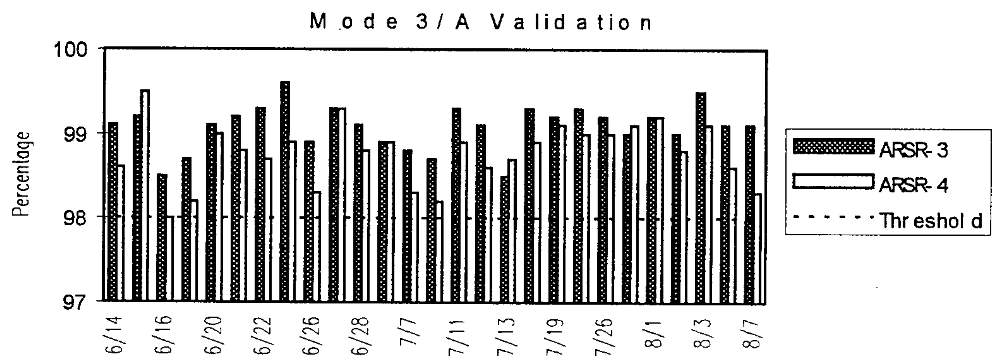

FIGURE 4.1.16-7. ARSR-4 AND ARSR-3 MODE 3/A VALIDATION RESULTS

Mode C Reliability and Validation results are shown in figures 4.1.16-8 and 4.1.16-9. All numbers exceeded QARS thresholds and results were comparable for each radar.

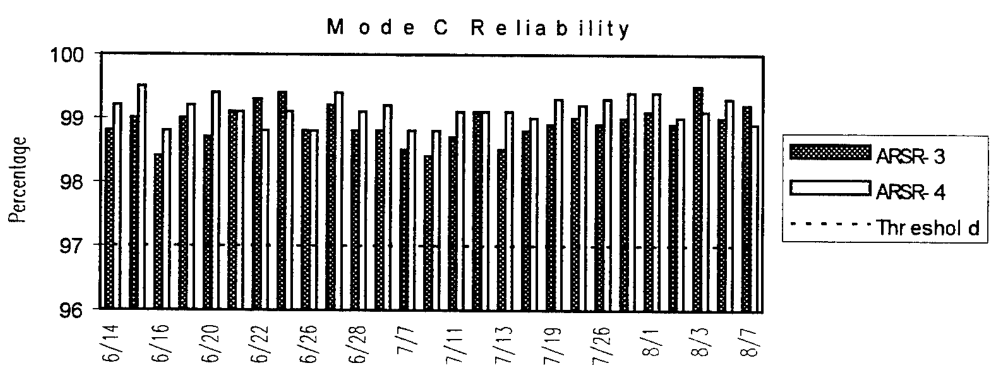

FIGURE 4.1.16-8. ARSR-4 AND ARSR-3 MODE C RELIABILITY RESULTS

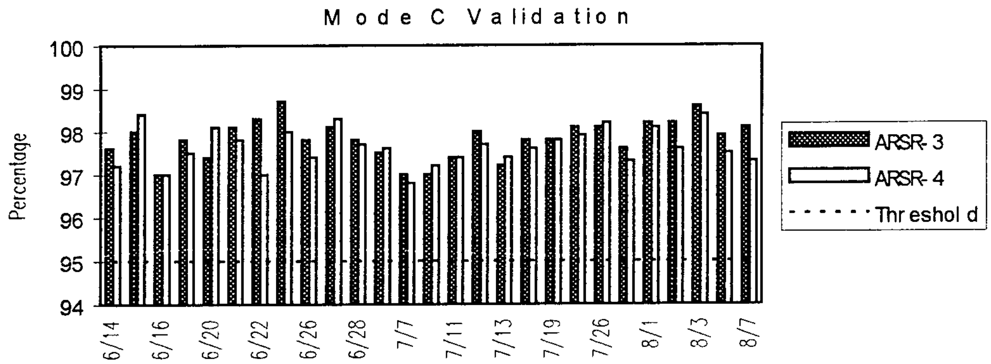

FIGURE 4.1.16-9. ARSR-4 AND ARSR-3 MODE C VALIDATION RESULTS

Conclusions
Beacon blip scan results indicate that the ARSR-4 performed slightly better than the ARSR-3 on most days. Both radars beacon detection exceeded QARS tolerances.

Search blip scan and reinforcement rate results show that the ARSR-4 performed better than the ARSR-3 on each day that data was collected. The lower ARSR-3 search detection is due to simplex operation. On each day, the ARSR-4 exceeded QARS tolerances in both categories.

Beacon azimuth and range splits were higher on the ARSR-4 than on the ARSR-3. On some days, the measured ARSR-4 split percentages exceeded the QARS tolerances while the ARSR-3 split percentages remained low. Further discussion of ARSR-4 split rate performance is presented in section 4.1.11.1 of this report.

Mode 3/A and Mode C validation and reliability results were comparable for both radars. These results surpassed QARS tolerances on each day.

Recommendations
ARSR-4 beacon parameter settings should be reexamined, and changed if necessary, to address the high split rate. If further parameter optimization does not solve the problem, then ARSR-4 beacon split algorithms may need to be modified. If the algorithms are changed, further testing should be performed to verify that the ARSR-4 meets both the split rate and beacon resolution requirements.

4.2 OT&E OPERATIONAL TESTS.

OT&E Operational tests evaluate the operational effectiveness and suitability of the ARSR-4 when operating in NAS.

4.2.1 Functional Performance - Controller Evaluations.

Purpose
Obtain input from air traffic controllers concerning the suitability and effectiveness of the ARSR-4 operating in NAS.

Test Objective

Verify that the ARSR-4, when configured in NAS, provides at least the capability of the ARSR-3 to the controller.

Test Description

The ARSR-4 performance in NAS was assessed by air traffic controllers at the Los Angeles ARTCC. ARSR-4 target of opportunity data was fed to the controllers during the test. Questionnaires, which addressed the functional performance characteristics of the radar and its interface into NAS, were filled out by the controllers.

The test period for controller evaluation of the system was divided into precertification and postcertification tests.

Precertification tests were performed with the ARSR-4 interfaced to DARC and the ARSR-3 interfaced to NAS. In this configuration, comparisons between the radars' performance could be made.

Postcertification tests were performed when the ARSR-4 data was being used operationally by Air Traffic. After the certification flight check, the ARSR-4 was configured as the primary radar and the ARSR-3 as the secondary radar in NAS.

Data Analysis

Controllers participated in development of the questionnaires as well as responding to the questions. The questions addressed: general ARSR-4/ARTCC interface capabilities, primary radar coverage, primary radar target detection, primary radar false alarm rate, primary radar accuracy, range and azimuth resolution, BTP code validation and accuracy, BTP splits and false reports, weather detection and processing.

Results

The questionnaires and controller responses are included in appendix D. Controller "Yes," "No," or "Not Observed" responses to each question are included along with any additional comments. The unshaded portions of the appendix tables correspond to responses from precertification tests and the shaded portions from postcertification tests.

"ARSR-4/ARTCC Interface" responses indicate that the ARSR-4 provides the basic information needed for ATC. During precertification tests, the ARSR-4 (interfaced to DARC) provided radar coverage better than or equal to that of the ARSR-3 (interfaced to NAS) in areas of known poor coverage.

Responses to "Primary Radar Coverage" questions varied. All of these questions were asked during postcertification tests, therefore, no comparison could be made between the ARSR-3 and the ARSR-4 coverage. The blanked area in the direction of the ARSR-3 tower was sometimes misinterpreted as a coverage hole in responses to some questions.

Most of the responses to "Primary Radar Target Detection" questions were "Not Observed."

Responses to "Primary Radar False Alarm Rate" questions show that those targets determined to be false by controllers do not have an adverse effect on the overall control of AT.

The general trend in responses to "Primary Radar Accuracy" questions indicate that the ARSR-4 provides sufficiently accurate data to determine the range and azimuth of a target and to adequately separate two aircraft.

Responses to "Range and Azimuth Resolution" questions indicated that the controllers were able to meet or exceed operational separation standards on those targets controlled during the test (i.e., targets of opportunity).

Responses to "Beacon Code Validation and Accuracy" questions indicate that the identification processing and the beacon code accuracy of ARSR-4 data was adequate for operational use.

Responses to "Beacon Splits and False Reports" questions show that splits and false reports were observed during the tests. This data is consistent with split results presented in the "ARSR-4 and ARSR-3 Comparison" section of this report.

Responses to weather detection and processing questions were inconclusive since no weather was in the Mt. Laguna area during the test period.

One problem, not shown in responses to questionnaires, arose during the certification flight check. For one scan, all beacon reports from the ARSR-4 were reported along the same azimuth. The problem corrected itself after the antenna crossed north. The problem was identified as an AT safety issue by controllers.

Conclusions

Controller responses to questionnaires indicate that:

The ARSR-4 provides the basic information needed for use in ATC.

a. The ARSR-4 provides adequate coverage for AT use.

b. The ARSR-4 data was accurate and allowed resolution of those targets seen during the test period.

c. The ARSR-4 produced beacon splits and false reports that were noticed by the controllers.

The problem concerning all beacon targets reported along one azimuth was identified as a serious problem by controllers. This problem was first noticed in March 1995, and was not seen again until the certification flight check.

Recommendations

Continued observation of system performance should continue and the impact of the beacon splits and false reports should be assessed by controllers.

The problem concerning all beacon targets reported along one azimuth radial should be addressed immediately. The fix should be followed by a demonstration where the problem can be reproduced when the radar does not have the fix and cannot be reproduced when the radar contains the fix to the problem.

4.2.2 Reliability, Maintainability, Availability.

Purpose

Ensure that the ARSR-4 provides data in a reliable manner to the ARTCC and that it can be maintained by site technicians.

Test Objective

a. Verify that the ARSR-4 achieves a mission Mean Time Between Critical Failure (MTBCF) of 1500 hours under the worst case environmental conditions. MTBCF is defined as the total ARSR-4 uptime divided by the number of critical hardware, software, and firmware failures that degrade Full Mission Capability (FMC).

b. Verify that the Mean Time Between Failure (MTBF) is greater than 100 hours. The MTBF is defined as the total ARSR-4 uptime divided by the total number of hardware, software and firmware failures that required corrective maintenance action.

Test Description

ARSR-4 reliability was assessed for the OT&E regression period from June 5,1995, through July 20, 1995. Two different software builds were loaded in the system during that time; the 25MAY95 and 13JUN95 builds. The 13JUN95 build was loaded into the system on July 8, 1995, to correct problems associated with the 25MAY95 build.

Data was collected using an MPS monitor which was connected to the ARSR-4 MPS port between June 5, 1995, and July 5, 1995. The MPS monitor recorded alarm and reconfiguration data. Any system anomalies or hardware failures were noted in the OT&E test and maintenance logs.

ARSR-4 maintainability was tested through verification of BIT/FIT operation and the ability of technicians to perform typical maintenance tasks. During BIT/FIT verification, faults were injected into the ARSR-4. BIT was monitored for the occurrence of an alarm and FIT was used to isolate the problem. ARSR-4 trained site technicians replaced any faulted hardware during the test period.

Data Analysis

The MTBF and MTBCF numbers were calculated by dividing the number of failures by the total test time.

During the test period, the ARSR-4 was actively operated by test personnel on-site. Therefore, the reliability was not assessed while the ARSR-4 operated in a benign user environment. Through correlation of log book entries and MPS data, those failures identified as being caused by test personnel were not counted against the ARSR-4 in the reliability assessment.

Results

Software Reliability

Three serious ARSR-4 problems, not observed with previous software builds installed, were discovered after the 25MAY95 software build was installed:

a. Global status polls issued from the remote MPS caused ARSR-4 system crashes. This is a critical operational failure.

b. Use of the ARSR-4 search test target generator with the second function tracker caused ARSR-4 system crashes. The problem was readily reproduced. This would pose a critical operational problem if site technicians used test targets to verify system performance while providing service to AT.

c. After recovery from a cold start or short-term power loss, false BIT hard alarms (Frequency Transition alarms) were reported for both synchronizers. At this time, the ARSR-4 was in critical alarm. The output of false BIT alarms is a critical failure and is cause for removal of the radar from NAS.

To enable continued testing of the ARSR-4/MPS interface, the 13JUN95 software build was installed at Mt. Laguna on July 8,1995. The build fixed the problem concerning MPS global status polls crashing the ARSR-4.

Although there was no fix for the STTG problem in the 13JUN95 build, that problem could not be duplicated with the 13JUN95 build installed in the system.

During the certification flight check (with the 13JUN95 build installed), an anomaly was noted where all beacon targets were reported along one azimuth for one scan. Normal beacon reporting resumed after resynchronization at north. This "beacon strobe" problem was identified as an AT safety issue by controllers. This is a critical operational failure.

Automatic system warm starts were counted for the time when the MPS monitor was connected to the system (between June 5,1995 and July 5,1995). In this period, the ARSR-4 experienced 69 automatic warm starts (approximately 2 per day). It should be noted that interference from the collocated ARSR-3 may have contributed to ARSR-4 warm starts and reconfigurations.

The ARSR-4 is configured with 10 CPUs, with an eleventh CPU provided for redundancy. During the test period, there were eight instances where one CPU was not available for processing data (the CPU status was either Unavailable-Faulted (UA-F) or Standby (STBY)). This is a loss of redundancy. There were two instances where two CPUs were unavailable at the same time, however, there was no observed data loss.

In six of the cases where at least one CPU was not available, a cold start was required to return the CPU to On-line (ONL). The cold start is a system reset which takes up to 3 minutes to complete. In one case, with two CPUs in STBY, user commanded warm starts did not return the CPUs to an on-line condition.

Hardware Reliability

A list of the ARSR-4 hardware replaced during the retest period is shown in table 4.2.2-1. As seen in the table, there were several instances of LDC failures during the test period. Although an LDC failure does not impact the data being sent to the ARTCC, there is a maintenance impact when an LDC has failed. The use of a MDT as a backup provides system control capability locally at the site, however, there is no means to backup PPI/RAPPI capabilities when the site LDC fails.

The failed 1:3 splitter was most likely due to a site power loss. Additional ARSR-4 power loss related problems are described in ARSR-4 to Power Subsystem section of this report.

TABLE 4.2.2-1. HARDWARE FAILURES DURING THE RETEST PERIOD

Date	Action Taken
6/05/95	Replaced faulted VDT in LDC #1.
6/13/95	Replaced LNA #10.
6/16/95	Replaced 1:3 Splitter.
7/13/95	Replaced Down Converter.
7/18/95	LDC #4 power supply replaced.
7/19/95	LDC #1 hung up during flight check. Power reset of LDC needed to restore operation.

Maintainability

The start of the OT&E/DT&E regression tests was postponed from the original start date of April 17, 1995, due to the overall instability of the ARSR-4. Symptoms of the problems included instances of CPU dropouts, data reports offset by approximately 30° from the actual azimuth, and many instances of beacon RTQC "dropouts" in the data sent to the ARTCC.

Westinghouse engineers dispatched to Mt. Laguna spent 3 weeks troubleshooting the problems using special WEC debugger tools (not available to the ARSR-4 site technician). Four faulty boards (one BCE, one BTX, and two RIBs) were removed from ARSR-4, each without a hard alarm indication from BIT.

Several other maintenance issues were revealed during testing:

a. ARSR-4 BIT does not monitor the voltages for the backup batteries for the Signal Processor or Data Processor. Adverse effects were seen when power was interrupted to the ARSR-4 while the batteries were not properly charged. More detail is provided in the ARSR-4 to Power Subsystem section of this report.

b. Inspection of revision levels on circuit boards in the system reveals that there is no permanent marking on the boards to indicate the revision level of the board.

c. At the end of the DT&E phase of testing, there was only 2 percent spare memory available for future system expansion.

Conclusions

a. The number of critical operational problems encountered during the test period was excessive. The critical problems associated with the 25MAY95 software build coupled with the "beacon strobe" problem during the certification flight check caused the MTBCF to be greater than one every 1500 hours.

b. Problems introduced with the installation of new software builds indicate that the builds are not effectively tested at the factory prior to delivery to the field. The result is that problems introduced with the new builds may impact the ability of the ARSR-4 to function in NAS.

c. The "beacon strobe" problem (the reporting of all beacon targets at one azimuth) is a serious operational problem which remained in the system at the end of OT&E.

d. The average of approximately two warm starts per day is most likely not a significant operational problem.

e. The ARSR-4's inability to automatically restore a faulted or standby CPU to on-line status without resetting the system is a serious operational concern. A system reset (cold start) can take up to 3 minutes to complete. During this time, the ARSR-4 is not available for use in NAS.

With CPUs dropped out of the mix, the site technician must decide whether to cold start the system (a site outage) to return the faulted CPUs or wait until additional CPUs fault before taking action.

f. The LDC was unreliable throughout the test period.

g. The ARSR-4 does not consistently recover from a short-term power loss.

h. With the exception of the LDC problems or power-related hardware problems, the ARSR-4 hardware was reliable during the test period.

i. In general, BIT/FIT detected and isolated those problems which were injected into the system using known methods. However, BIT/FIT did not detect/isolate failures in four boards in the data processor prior to start of the retest. This indicates that not all possible faults were injected into the system during testing. The level of BIT/FIT effectiveness in detecting/isolating problems with faulted boards is unknown.

j. The labeling of revision levels on the circuit boards in the system is inconsistent and confusing.

k. The available spare memory in the ARSR-4 will not be sufficient to support future system corrections or upgrades.

l. The status of backup battery voltages is not reported by BIT. Data can be lost to the user if the ARSR-4 experiences a power loss while the backup batteries are faulty or uncharged.

Recommendations

a. The ARSR-4 should not be operated in NAS until the identified critical problems have been corrected and successfully retested. The "beacon strobe" problem should be corrected immediately. Software should be fixed to automatically restore faulted and standby CPUs to on-line status without requiring a system reset.

b. After fixes for critical problems have been incorporated, the reliability of the system should be assessed over an extended period of time. The ARSR-4 should not be operated in an unmanned environment until the system reliability has been improved.

c. New software builds should be fully tested at the factory and at a test site prior to reaching the end users in the field. Benchmark tests that are being developed for this purpose should be implemented immediately. The benchmark tests should be fine tuned over time based on the effectiveness of the tests. When the Program Support Facility (PSF) becomes available, the resources will exist to provide more extensive testing of new builds.

d. The number of automatic warm starts and reconfigurations should be counted again when the ARSR-4 is not collocated with the ARSR-3. The operational impact should then be assessed.

e. Since the LDC reliability was poor during testing, the MDT should be used as a backup for the LDC at each site. A decision for replacing the LDC should be made at a later date after more reliability data has been collected.

f. An UPS should be installed on every ARSR-4.

g. Fault detection should be improved for the four boards (1 BCE, 1 BTX, and 2 RIBs) removed from the system prior to OT&E retest. ARSR-4 fault detection and isolation should be improved as more failure data is compiled.

h. BIT/FIT should not be used as the only means to maintain the ARSR-4. An alternate plan (such as troubleshooting flowcharts) should be developed to assist the radar technician in troubleshooting problems when BIT/FIT do not detect or isolate faults. The alternate procedures should be incorporated into the ARSR-4 site technician training and updated as more failure data is compiled.

i. ARSR-4 circuit boards should have permanent markings of serial and part numbers with an accurate revision level stamped on each board.

j. The spare memory available in the ARSR-4 should be increased to support system upgrades, future system expansion, or corrections for any future problems.

k. The frequency of maintenance checks should be increased for those ARSR-4 components which are not monitored by BIT and have been observed to fail before the current scheduled maintenance check was performed (such as the backup batteries for the Signal Processor and Data Processor).

4.2.3 Site Adaptation and Optimization.

Purpose
Evaluate the ability to optimize the ARSR-4 to site specific conditions. Determine the ability of the ARSR-4 to adapt to environmental changes without frequent reoptimization.

Test Objective
Verify that the ARSR-4 can be optimized using standard equipment available with each ARSR-4.

Test Description
The Mt. Laguna ARSR-4 was optimized by AOS-230 and USAF personnel. Site adjustable parameters, antenna tilt, and site maps were set up to satisfy the coverage requirements of the FAA and the military. Data collection and analysis were performed during the optimization process to verify that the parameter settings were correct.

Data Analysis
ARSR-4 performance was monitored throughout OT&E. Any problems related to incorrect site optimization or adaptation were documented in the test log book.

Results
The ARSR-4 provided sufficient flexibility in the site adjustable parameters to optimize the radar. However, the optimization period was lengthy. Since the Mt. Laguna ARSR-4 will be used for FAA and USAF applications, several iterations of parameter adjustment, data collection, and analysis were required to ensure that the optimized radar satisfied both users' requirements.

One problem noted during OT&E was a hole in coverage to the east of the site (the problem and solution are detailed in section 4.1.6 of this report). Changes were easily made to geocensor stop range SAPs to address the coverage problem. However, the reduced geocensor thresholds did not completely eliminate the problem.

A second problem concerned the reporting of false weather to controllers during periods of anomalous propagation. The ARSR-4, as configured, did not adapt to the environmental conditions. However, the false weather was not identified as a serious operational problem at the Los Angeles ARTCC.

Conclusions
The ARSR-4 design allows the system to be optimized, adapted to site conditions, and certified. The amount of time required to optimize future systems should decrease as experience is gained in the optimization process.

The ARSR-4 output false weather to the user when anomalous propagation conditions were prevalent. The false weather was not identified as a serious operational problem by controllers at the Los Angeles ARTCC. The ability of the ARSR-4 to adapt to environmental conditions such as anomalous propagation is limited.

Recommendations
The impact of false weather caused by anomalous propagation should be evaluated at each site. If the false weather is more severe at other locations, causing operational problems, steps (either through procedural changes or redesign) should be taken to ensure that the ARSR-4 can automatically adapt to these environmental conditions.

4.2.4 Human Factors.

Purpose
Evaluate user interfaces to ensure that maintenance and operational functions can be effectively performed.

Test Objectives

a. Verify that the systems' equipment design conforms to human engineering design criteria and principles to achieve safe, reliable, and effective performance by operator and maintenance personnel and to minimize personnel skill requirements and training time.

b. Verify that ambient noise levels are tolerable to site personnel with the simultaneous operation of all equipment, including the I/O devices.

c. Verify that all ARSR-4 equipment is configured so as to provide ready access for replacement at the LRU level.

Test Description
Routine maintenance functions were observed during the test period and the ease with which these functions could be performed was evaluated. Any anomalies were documented in the test log book on site. Ambient working conditions (lighting, noise) were observed and any problems noted.

Results
The circuit boards in the four bay are easy to remove and install.

The RMS screens are easily traversed via the LDC or MDT.

The lighting in the ARSR-4 equipment rooms was adequate with the exception of the RCJB, where no lighting was provided. Therefore, it is difficult to view cabling and connections.

The ambient noise in the ARSR-4 transmitter and four bay rooms was noted to be excessive. A single noise baffle was positioned on the Signal Processor cabinet. The baffle significantly reduced the noise level from the Signal Processor cabinet relative to adjacent cabinets and produced no apparent adverse effects due to insufficient air flow in the cabinet. Other baffles were on order at the completion of testing.

Conclusions
ARSR-4 circuit boards are easily substituted during maintenance.

The lighting is adequate in the ARSR-4 equipment room with the exception of the RCJB, where more light is needed.

The addition of a sound baffle on the Signal Processor cabinet significantly reduced noise from the cabinet. Addition of baffles on the remaining cabinets should significantly reduce ambient noise in the transmitter and four bay rooms.

4.2.5 Safety.

Purpose
Evaluate the ARSR-4 for unsafe conditions.

Test Objective
Verify that system equipments are designed and constructed so that the potential for personal injury during installation, operation, and maintenance is minimized.

Test Description
The ARSR-4 and its environment were inspected by site personnel during OT&E. Any unsafe conditions were documented in the test log book and in test discrepancy reports.

Results
Several problems associated with the ARSR-4 power installation were discovered:

a. Some grounds were bonded to painted surfaces.

b. The cables installed to ground cabinets in the four bay were improperly gauged and would not handle the significant current required.

c. A neutral wire run from the radar power panel to the transmitter room was left unterminated in a raceway in the transmitter room.

A grounding team from the Western Pacific region addressed these installation problems at Mt. Laguna. After several corrections to grounds, the team reported that the radar was safe.

A second safety issue concerned water on the floor in the antenna deck. Water on the pedestal floor causes a slipping hazard, particularly when the water freezes. There were three sources for the water. The first source was a leaking radome. Several recaulking attempts by the radome subcontractor proved unsuccessful in stopping these leaks. The second source was leakage through the pedestal floor. During storms with high winds at Mt. Laguna, water is forced upward between floor panels. The third source for the water was entry through vents in the radome.

A third safety issue was water in the transmitter room. On one occasion, during a storm, the ARSR-4 was turned off because of site power problems. Power was not restored for several days. When power was returned to the system, a 2:1:8 splitter hard alarm was reported for the transmitter. Further investigation revealed that the 2:1:8 splitter was full of water.

When the ARSR-4 power was turned off, the louvers on the exhaust ducts above the transmitter were not closed. Rain was blown into the duct and eventually settled in the transmitter cabinet. The battery operated louver motor, which is designed to close the exhaust duct louvers upon loss of power, did not function because the battery was not charged. The cause for the uncharged battery (either a bad battery, lack of maintenance, or improper installation) was not known. The voltage for this battery is not monitored by BIT.

After another storm, a puddle was found on the floor in the transmitter room under the transmitter circuit breaker panel. The water leaked from the louver motor enclosure located on the wall next to the transmitter. The unit was recaulked. However, it could not be checked due to insufficient rain opportunities.

Conclusions

After a Western Pacific Region power team corrected improper grounding on the Mt. Laguna ARSR-4, they deemed that the ARSR-4 power/grounding was safe.

Water on the antenna deck can cause a slipping hazard.

If the exhaust duct louvers remain open when the air handler is turned off during a rainstorm, rain can be blown into the transmitter exhaust duct and eventually settle in the transmitter. This should not be a problem under normal operating conditions, with the air handler on, because air pressure from the air handler would prevent the rain from blowing into the duct.

Recommendations
Careful inspection of power/grounding should be made after installation of every ARSR-4.

The water/precipitation leakage onto the antenna deck should be corrected to prevent a personnel slipping or electric shock hazard.

Since BIT does not monitor the louver motor battery voltage, the frequency of maintenance checks should increase for these batteries. In addition, power to the air handler should not be disconnected during rainstorms.

4.2.6 Security.

Purpose
Evaluate the ARSR-4 system design for security of classified data and system control.

Test Objectives

a. Verify that the configuration and parameter settings of the ARSR-4 cannot be modified by unauthorized personnel.

b. Verify that the ARSR-4 design does not prohibit operation at an unmanned site due to security reasons.

Test Description
Limited security tests were performed by ACT-310 personnel through inspections of RMS menus on the LDC which require a security clearance and through testing of BIT alarm reporting associated with the Mode 4 safe door and KIR status.

Results
Password protection is available for ARSR-4 system control security at the LDC and MDT.

ACT-310 personnel were unable to access classified information on the RMS menus without entering a password for access to the LDC. The classified information located in the Mode 4 safes was secure. The safe door combination locks were in working order. In addition, the built in test functions related to the safe and its contents worked. The proper bits were set in the SOCC status message when the safe doors were opened or when the KIR was removed.

Interlocks for the antenna door and radome catwalk door functioned correctly.

Conclusions
Limited tests performed by ACT-310 personnel show that the ARSR-4 classified data is secure.

Recommendations
If the ARSR-4 radar sites go to unmanned operation or if site manning is reduced, site procedures should be reevaluated by FAA and USAF security specialists to ensure that the building and its contents are secure.

5. SIGNIFICANT CONCLUSIONS.

The conclusions presented in this section are based on Operational Test and Evaluation (OT&E) test results. Air Route Surveillance Radar Model Four (ARSR-4) OT&E was conducted at Mt. Laguna, California, from May 23, 1994, through January 15, 1995 (using multiple software builds) and from June 1, 1995, through August 11, 1995 (using the 25MAY95 and 13JUN95 software builds).

a. Results showed that the ARSR-4 performs most basic surveillance functions well. Improved ARSR-4 coverage (when compared to ARSR-3 coverage) was noted, especially in areas with a history of poor coverage. Controller responses to questionnaires indicated that the ARSR-4 provides the basic information needed for use in air traffic control (ATC).

b. The ARSR-4 at Mt. Laguna had a significantly higher beacon split rate than the ARSR-3. The higher split rate often exceeded Quick Analysis of Radar Sites (QARS) tolerances which are used to certify the radar in the National Airspace System (NAS).

c. The ARSR-4 did not perform reliably during the test period. The number of critical operational problems encountered was excessive. The critical problems associated with the 25MAY95 software build coupled with the "beacon strobe" problem (the reporting of all beacon targets at one azimuth) during the certification flight check caused the Mean Time Between Critical Failure (MTBCF) to be greater than one every 1500 hours. The "beacon strobe" problem remained in the system at the end of OT&E. The problem was identified as a serious operational problem by controllers.

d. Problems introduced with the installation of new software builds during OT&E indicated that the software was not effectively tested at the factory prior to delivery to the field. Ineffective factory testing may impact the ability of the ARSR-4 to function in NAS.

e. The ARSR-4, as configured at Mt. Laguna, did not consistently recover from a short-term power loss (less than 15 seconds). On many occasions, the ARSR-4 reported a large number of false Built-in Test (BIT) alarms and false search reports after power loss. The safe data and configuration segments, routinely saved to Electrically Eraseable Programmable Read Only Memory (EEPROM) during a power loss, can become corrupted during brownout conditions. Also, when one or more phases of site power are dropped, transmitter hardware is often damaged.

f. The ARSR-4's inability to automatically restore a faulted or standby central processing unit (CPU) to on-line status without resetting the system is a serious operational concern. A system reset (cold start) can take up to 3 minutes to complete. During this time, the ARSR-4 is not available for use in NAS. With CPU(s) dropped out of the mix, the site technician must decide whether to cold start the system (a site outage) to return the faulted CPUs or wait until additional CPUs fault before taking action.

g. In general, BIT/Fault Isolation Test (FIT) detected and isolated those faults injected into the system using known methods. However, BIT/FIT did not detect/isolate failures in four

boards in the data processor prior to start of the retest. This indicates that not all possible faults were injected into the system during testing. The level of BIT/FIT effectiveness in detecting/isolating problems with faulted boards is unknown.

h. The status of backup battery voltages is not reported by BIT. Data can be lost to the user if the ARSR-4 experiences a power loss while the backup batteries are faulty or uncharged.

i. The spare memory, available in the ARSR-4 at the end of OT&E, will not be sufficient to support future system corrections or upgrades.

j. The ARSR-4 successfully completed capacity and delay tests during Development Test and Evaluation (DT&E) Software Performance Qualification Test (SPQT) 16. Limited OT&E capacity and delay tests showed that the ARSR-4 can process and provide message outputs for a steady state maximum load of 800 aircraft returns within the primary radar coverage area in the Air Traffic Control Beacon Interrogator (ATCBI) configuration.

k. The ARSR-4 met the 2.2 square meter primary range and azimuth resolution requirements (50 percent requirement). However, the ARSR-4 failed 10 square meter primary range and azimuth resolution tests (a more stringent 90-percent requirement). The ARSR-4 failed to resolve the larger targets when separated by greater than the minimum azimuth resolution requirements. Targets with an azimuth separation of 2° to 3° which also have a range separation of greater than 1/8 nautical mile (nm) (but less than 1/4 nm) are resolved only between 25 and 40 percent of the time, well below the necessary 90-percent resolution. This resolution "hole" indicates a problem in the ARSR-4 resolution algorithms.

l. The ARSR-4 weather detection and reporting capability was not fully evaluated at Mt. Laguna due to the unavailability of significant weather in the area. Limited tests using test targets showed that the ARSR-4 weather processor can process and display three or five levels of weather on the Local Display Console (LDC) at the correct position.

The Direct Access Radar Channel (DARC) system displays ARSR-4 weather information differently than the HOST. The inconsistent weather processing between Air Route Traffic Control Center (ARTCC) computers is not suitable for ATC.

m. Full control of the ARSR-4 can be performed from any terminal (i.e., LDC, Maintainence Display Terminal (MDT), Transmitter MDT (TMDT)) at the local site. The ARSR-4 Remote Monitoring Subsystem (RMS) allows the site technician to reconfigure radar elements, monitor system performance and initiate internal BIT and FIT functions. In addition, the RMS allows for easy adjustment of parameters and control of ARSR-4 data extraction functions.

n. The ARSR-4 design allows the system to be optimized, adapted to site conditions, and certified. However, during OT&E, the ARSR-4 output false weather to the user when anomalous propagation conditions were prevalent. This indicates a limitation in the ability of the ARSR-4 to automatically adapt to some changing environmental conditions.

o. The ARSR-4 to ARTCC interface operates effectively. The ARSR-4 reports all expected message types in the correct format to the ARTCC. The ARSR-4 successfully detects failed modem ports and automatically reconfigures redundant serial Input/Output (I/O) boards on-line in the event of a communications failure. Beacon emergency, Real-Time Quality Control (RTQC), and status messages are correctly given priority on the interface during buffer overload and buffer overflow conditions.

p. The ARSR-4, as described in the ARSR-4 to Mode Select (Mode S) Interface Control Document (ICD), will not interface with the Mode S in its present configuration. In addition, test results revealed that ARSR-4 status is not correctly reported to Mode S for some of the status bits.

q. The ARSR-4 does not integrate effectively with the Radar Remote Weather Display System (RRWDS). Several problems were discovered which prohibit an effective interface between the two systems. First, the ARSR-4 weather video voltage levels are excessive. Second, the RRWDS does not display weather at the correct azimuth due to the coincidence of the ARSR-4 generated Azimuth Reference Pulse (ARP) with an Azimuth Change Pulse (ACP). Third, proper alignment procedures do not exist for the ARSR-4/RRWDS interface.

6. SIGNIFICANT RECOMMENDATIONS

a. The Air Route Surveillance Radar Model Four (ARSR-4) should not be operated in the National Airspace System (NAS) until the identified critical problems have been corrected and successfully retested. The "beacon strobe" problem (where all beacon targets are reported along one azimuth radial) should be corrected immediately. Software should be fixed to automatically restore faulted and standby Central Processing Units (CPUs) to on-line status without requiring a system reset. After fixes for critical problems have been incorporated, the reliability of the system should be assessed over an extended period of time.

b. The ARSR-4 should be operated with an Uninterruptible Power Supply (UPS) in addition to a reliable backup engine generator in order to avoid most of the power related problems described in this report. In addition, there should be capability added to ARSR-4 Built-in Test (BIT) to allow monitoring of Signal Processor and Data Processor backup battery voltages.

c. New software builds should be fully tested at the factory and at a test site prior to reaching the end users in the field. Benchmark tests that are being developed for this purpose should be implemented immediately.

d. BIT/Fault Isolation Test (FIT) should not be used as the only means to maintain the ARSR-4. An alternate plan (such as troubleshooting flowcharts) should be developed to assist the radar technician in troubleshooting problems when BIT/FIT do not detect or isolate faults. The alternate procedures should be incorporated into the ARSR-4 site technician training and updated as more failure data is compiled.

e. The spare memory available in the ARSR-4 should be increased to support system upgrades, future system expansion, or corrections for any future problems.

f. The cause for the high ARSR-4 beacon split rate at Mt. Laguna should be identified and corrected. ARSR-4 beacon parameter settings should be reexamined, and changed if necessary, to address the high split rate. If further parameter optimization does not solve the problem, then ARSR-4 beacon split algorithms may need to be modified. If the algorithms are changed, further testing should be performed to verify that the ARSR-4 meets both the split rate and beacon resolution requirements.

g. The operational significance of the range resolution hole between 1/8 nautical mile (nm) and 1/4 nm should be evaluated by Air Traffic (AT) personnel. If the hole is deemed to be an operational problem, then corrections should be made to the ARSR-4 resolution algorithms and those fixes should be retested.

h. Direct Access Radar Channel (DARC) weather processing should be corrected to coincide with the weather processing in NAS so that consistent weather information is reported to the controller when the backup system is switched on-line. In addition, further weather tests should be conducted at another ARSR-4 site where weather is more prevalent. ARSR-4 weather products should be compared to weather products from National Weather Service (NWS) radars to verify accurate weather reporting.

i. The impact of false weather caused by anomalous propagation should be evaluated at each site. If the false weather is more severe at other locations, causing operational problems, steps (either through procedural changes or redesign) should be taken to ensure that the ARSR-4 can automatically adapt to these environmental conditions.

j. The ARSR-4/Mode Select Beacon System (Mode S) Interface Control Document (ICD) and ARSR-4 system design should be corrected to enable interface with the Mode S. A full integration test is recommended for the first site which has an ARSR-4 and a Mode S. The test should include data throughput, format verification, capacity and delay, channel switching, and Mode S/Mode 4 compatibility tests.

k. Consideration should be given to eliminating the Radar Remote Weather Display System (RRWDS) from the ARSR-4 weather path to the Air Route Traffic Control Center (ARTCC). Digital weather messages from the ARSR-4 six level weather processor should be sent directly to the ARTCC. This approach would require changes to the ARSR-4 formatter and the development of a weather video reconstitutor for location at the ARTCC.

7. ACRONYMS AND ABBREVIATIONS.

ACP	Azimuth Change Pulse
AGL	Above Ground Level
APG	Azimuth Pulse Generator
APMT	Associate Program Manager for Test
ARP	Azimuth Reference Pulse
ARSR-4	Air Route Surveillance Radar (Model 4)
ARTCC	Air Route Traffic Control Center
ASR-9	Airport Surveillance Radar (Model 9)
AT	Air Traffic
ATC	Air Traffic Control
ATCBI	Air Traffic Control Beacon Interrogator
BAM	Burst Agile Mode
BCE	Beacon Code Extractor
BCOL	Beacon Channel On-line
BER	Block Error Rate
BEXR	Beacon Extractor and Recorder
BIT	Built-In Test
BMI	Basic Measurement Instruments
BO	Beacon Only
BRTQCA	Beacon Real-Time Quality Control Alarm
BRX	Bus Receiver Board
BTP	Beacon Target Processor

BTX	Bus Extender Board
CD-2	Common Digitizer 2
COI	Critical Operational Issue
COTS	Commercial-Off-The-Shelf
CPU	Central Processing Unit
CQMS	Circuit Quality Monitoring System
CW	Constant Wave
DARC	Direct Access Radar Channel
dB	decibel
DCE	Data Communication Equipment
DT&E	Development Test and Evaluation
DTE	Data Terminal Equipment
EARTS	Enroute Automated Radar Tracking System
EEPROM	Electrically Eraseable Programmable Read Only Memory
EMI	Electromagnetic Interference
FAA	Federal Aviation Administration
FACSFAC	Fleet Area Control Surveillance Facility
FAP	Field Adjustable Parameter
FIT	Fault Isolation Test
FMC	Full Mission Capability
FRUIT	False Replies Unsynchronous In Time
GFE	Government Furnished Equipment
GPS	Gobal Positioning System

GRAM	Global Random Access Memory
GSV	General Site Verification
Hz	hertz
IBI	Interim Beacon Interrogator
ICD	Interface Control Document
IF	Intermediate Frequency
IMCS	Interim Monitor and Control Software
I/O	Input/Output
IOT&E	Independendent Operational Test and Evaluation
IP	Interpulse Period
IRES	Integrated Radar Evaluation System
ISM	Integral Systems Monitor
LDC	Local Display Console
LNA	Low Noise Amplifier
LRU	Logical Replaceable Unit
M4ALA	Mode 4 Alarm
MDS	Minimum Discernable Signal
MDT	Maintainence Display Terminal
MHz	megahertz
MircoEARTS	Microprocessor-based Enroute Radar Tracking System
MODE-S	Mode Select Beacon System
MPS	Maintenance Processor System
μs	microsecond

ms	millisecond
MSL	Mean Sea Level
MTBCF	Mean Time Between Critical Failure
MTBF	Mean Time Between Failure
MTI	Moving Target Integrator
NAS	National Airspace System
NCP	NAS Change Proposal
nm	nautical mile
ns	nanosecond
NWS	National Weather Service
ONL	On-line
ORD	Operational Requirements Document
OT&E	Operational Test and Evaluation
P04STA	Port Status Alarm
PAM	Pulse Agile Mode
PE	Permanent Echo
PPI	Plan Position Indicator
PRF	Pulse Repetition Frequency
PRT	Pulse Repetition Time
PSF	Program Support Facility
PULS	Pulse Agile
QARS	Quick Analysis of Radar Sites
RADES	84th Radar Evaluation Squadron

RAM	Random Access Memory
RAPPI	Random Access Plan Position Indicator
RB	Radar Beacon Merge
RBPM	Radar Beacon Performance Monitor
RCJB	Radar Control Junction Box
RCS	Radar Cross Section
RF	Radio Frequency
RFBITS	Radio Frequency Beacon Interrogator Test Set
RHI	Range Height Indicator
RIB	Radar Interface Board
RLS	Radar Line of Site
RMMS	Remote Maintenance Monitoring Subsystem
rms	root-mean-squared
RMS	Remote Monitoring Subsystem
RO	Radar Only
RR	Radar Reinforced
RRWDS	Radar Remote Weather Display System
RTQC	Real-Time Quality Control
SAP	Site Adjustable Parameter
SCV	Sub-clutter Visability
SIO	Serial Input / Output
SOCC	Sector Operations Control Center
SPI	Special Position Identification

SPQT	Software Performance Qualification Test
STAC	Second Time Around Clutter
STBY	Standby
STC	Sensitivity Time Control
STTG	Search Test Target Generator
TDR	Test Discrepancy Report
TIS	Time In Storage
TMDT	Transmitter Maintenance Display Terminal
TQA	Track Quality Assessment
TTR	Test Trouble Report
UA-F	Unavailable / Faulted
UPS	Uninterruptable Power Supply
USAF	United States Air Force
VDT	Video Display Terminal
VideoBITS	Video Beacon Interrogator Test Set
VIP	Variable Interpulse Period
VSWR	Voltage Standing Wave Ratio
WEC	Westinghouse
WXCHST	Weather Channel Status

APPENDIX A

TEST DISCREPANCY REPORT (TDR) SUMMARY

OT&E TEST DISCREPANCY REPORT SUMMARY

To track and identify each test failure or system problem discovered during OT&E, TDRs were developed. These reports identify the test in progress, ARSR-4 software build in use, criticality of the problem, a description of the problem/failure, and recommended course of action.

Table 1. provides a summary of the 155 TDRs written by ACT-310 during the OT&E test period. Included in this table is the TDR number, the date the TDR was developed, a brief description, the criticality of the problem, and the closure status.

Problem criticality is listed as Serious, Moderate, or Minor. Serious problems include those items which must be corrected for the ARSR-4 to properly operate as part of the NAS. Those TDRs with Serious criticality which remain open after completion of retest are shaded in the Criticality column of the table.

Moderate problems are those which primarily effect user ability to maintain the radar. Problems identified as Minor are those discrepancies which are an annoyance and result in increased work for the end user.

The TDR status definitions include: Open, Closed, or Retest. The "Open" status identifies problems which have no agreement with WEC to correct. The "Retest" status classifies those items which are believed by WEC to be corrected through software or hardware changes to the ARSR-4, or items that WEC could not duplicate which may have been fixed by software changes during OT&E. Finally, discrepancies marked as "Closed" were corrected through system modifications and/or contractor documentation, and verified through retest.

A few items contain a status which is not listed in the previous paragraph. AOS will implement a fix to the problem identified in TDR #11 using COTS components. Retest will be conducted with the AOS implementation. The Overflow errors on RRWDS referenced in TDR #12 are probably not an operational concern. However, the impact on the maintenance of the RRWDS needs to be determined.

TDR #	Date	Description of TDR	Pre-DRR	Criticality	Status
1	6/7/94	Port 6 and 7 RCJB jack assignment reversal		Minor	Closed (6/10/94)
2	6/7/94	Data Extraction aborts with Synchronizer Reconfiguration		Minor	Open
3	6/7/94	RTQC Target Dropouts		SERIOUS	Closed (7/14/95)
4	6/7/94	Data not Distributed over remaining ports when a port fails		SERIOUS	Closed (7/6/95)
5	6/7/94	LP/CP status does not function in Status Message to ARTCC		SERIOUS	Closed (6/15/95)
6	6/7/94	WXCHST field always indicates Wx channel as Failed		SERIOUS	Closed (8/31/94)
7	6/7/94	BIT not alarming on unterminated user ports (ie. failed port)		Moderate	Closed (6/15/95)
8	6/7/94	FIT does not isolate a failed user port		SERIOUS	Closed (6/15/95)
9	6/7/94	Incorrect MPS message when FIT runs on Data Processor		Moderate	Closed (6/28/95)
10	6/8/94	Low System Reliability (3 Critical Failures and 87 WS over 21 days)	X	SERIOUS	Open
11	6/23/94	Excessive RRWDS Video Levels from the ARSR-4	X	SERIOUS	AOS to implement
12	6/23/94	Overflow errors indicated on RRWDS when connected with ARSR-4		Minor	Determine impact
13	6/23/94	Two additional Critical failures since 6/7/94 (3 scan WS with CPU loss)	X	SERIOUS	Open
14	6/23/94	Three LDC/RMS Terminal lockups, One LDC/RAPPI Lockup		SERIOUS	Open
15	6/23/94	Failure to recover from Power Loss (Weather Station Alarms)		SERIOUS	Closed - See TDR 151
16	6/23/94	Task Time-out loading Geocensor Map, Cold Started to recover		Moderate	Open
17	6/23/94	RMS Stuck in Menu 5.2		Minor	Closed (6/28/95)
18	7/1/94	DE would not run after performing FIT during a previous DE		Moderate	Closed (6/28/95)
19	7/1/94	Test Targets do not shut OFF when switching from MAINT to REPR		Minor	Open
20	7/1/94	LDC locked up when printing a RMS menu screen		SERIOUS	Open
21	7/1/94	Intermittent RRWDS Video alarm with ARSR-4 connected to RRWDS		SERIOUS	Closed (7/14/95)
22	7/18/94	BRX Boards are not redundant (ie. single point of failure)		Moderate	Closed (11/11/94)
23	7/18/94	Military Emergency Bit set on non-emergency targets		SERIOUS	Closed (6/28/95)
24	7/18/94	BETAPR field is reporting incorrect status to the ARTCC		SERIOUS	Closed (6/15/95)
25	7/18/94	Data Processor indicates 100% operational with the BCE board removed		Moderate	Closed (6/28/95)
26	7/18/94	System lockup and target losses when switching Wx and STBY Detection		SERIOUS	Closed (6/28/95)
27	7/18/94	WXCHST field reporting incorrect status when WX channel failed		SERIOUS	Closed (6/15/95)
28	7/18/94	OLBA failed to alarm when quantized video from ATCBI was removed		Moderate	Closed (11/11/94)
29	7/18/94	M4ALA alarm did not occur with Mode 4 transmission in a prohibited sector		SERIOUS	Closed (6/15/95)
30	7/18/94	OLRBAL did not alarm with the RBPM enabled but disconnected		Moderate	Closed (7/14/95)
31	7/18/94	OUSRA*, TIS, BOA, BOFA were not reported with these conditions		SERIOUS	Closed (7/6/95)
32	7/18/94	DM CH* STC/Bird WX Map Verify alarms on RMS, Cold Start needed		Moderate	Closed (7/14/95)
33	7/18/94	SRTQC alarm was not reported to the ARTCC		SERIOUS	Closed (6/15/95)
34	7/20/94	Polarization changes are not being reported in the POLCHA field		SERIOUS	Closed (6/15/95)

Table 1. OT&E Test Discrepancy Reports (May 23, 1994 through August 1, 1995)

Table 1: OT&E Test Discrepancy Reports (May 23, 1994 through August 1, 1995)					
TDR #	Date	Description of TDR	Pre-DRR	Criticality	Status
35	7/20/94	Mode 4 operation changes not reported in the SUM4ON field		SERIOUS	Closed (6/15/95)
36	7/20/94	Output service alarms are not being reported in the MODALA field		SERIOUS	Closed (6/15/95)
37	7/20/94	SRTQCA alarm was not reported to the SOCC		SERIOUS	Closed (6/15/95)
38	7/20/94	BETAPR field did not report an alarm to the SOCC with beacon video		Moderate	Closed (11/11/94)
39	7/20/94	BOFA and USRALA alarms not reported to SOCC when ports overflow		SERIOUS	Closed (6/15/95)
40	7/20/94	KRSTAT and M4PRST alarms were not reported to the SOCC		SERIOUS	Closed (7/6/95)
41	7/20/94	FRSOST alarm was not reported to the SOCC with a freq gen alarm on		SERIOUS	Closed
42	7/20/94	Incorrect alarm threshold adjustments reported to the MPS		SERIOUS	Closed (6/28/95)
43	7/20/94	DEFKA bit to the SOCC does not function		SERIOUS	Closed
44	7/20/94	M4INOR and M4ALA alarms did not report a prohibited Mode 4		SERIOUS	Closed (6/15/95)
45	7/20/94	Loss of receiver redundancy was not reported in the RCVSTA field		SERIOUS	Closed (6/15/95)
46	7/20/94	A critical DP failure was not reported in the DPRIST field to the SOCC		SERIOUS	Closed (6/28/95)
47	7/20/94	SPSTAT field did not report a loss of redundancy to the SOCC		SERIOUS	Closed (6/15/95)
48	7/20/94	Loss of redundancy was not reported in the TXSTAT field to the SOCC		SERIOUS	Closed (6/15/95)
49	8/16/94	Received a faulty error message when calibrating the RF ports		Moderate	Open (7/3/95)
50	8/16/94	RF power readings on the RMS do not update when no RF is transmitted		Moderate	Closed (7/14/95)
51	8/16/94	Pedestal HA's did not clear when thresholds were returned to normal		Moderate	Closed (6/15/95)
52	8/16/94	Transmitter HA's did not clear when thresholds were returned to normal		Moderate	Closed
53	8/16/94	Radome Obstruction Light A is reporting a HA with the light illuminated		Moderate	Closed (11/11/94)
54	8/16/94	MDT failure resulted in a complete loss of system control		SERIOUS	Closed (6/28/95)
55	8/16/94	RC CH* STC EEPROM Checksum HA's present and could not be cleared		Moderate	Closed (7/14/95)
56	8/16/94	ARSR-4 automatically cold started when commanding an STC load		SERIOUS	Closed (6/28/95)
57	8/16/94	Data Extraction indicates pause during non-capacity loading		Moderate	Closed (6/28/95)
58	8/16/94	Time Clock on RMS menu 6 halted when the MDT accessed menu 6		Minor	Closed (11/11/94)
59	8/16/94	The Index of Refraction and Ka values are not updating from a cold start		SERIOUS	Closed (6/15/95)
60	8/16/94	The LDC/RMS locked up when entering a DE filename		SERIOUS	Closed (6/28/95)
61	8/16/94	The PPI/RAPPI display size did not change when resizing the LDC		Minor	Open
62	8/16/94	ARSR-4 did not recover from a short term power loss (< 5 sec)		SERIOUS	Closed - See TDR 151
63	8/31/94	Some target reports are incorrectly time stamped		SERIOUS	Closed (7/14/95)
64	8/30/94	COHO status alarm was not reported when the COHO was disabled		Moderate	Closed (11/11/94)
65	8/30/94	FIT aborted due to scheduling conflicts when ran to detect a disabled		Moderate	Closed
66	8/30/94	FIT did not operate correctly with a fault in the waveform generator		Moderate	Closed
67	8/30/94	SP cabinet blower alarms #1 and #2 are reversed		Minor	Closed (11/11/94)
68	8/30/94	FIT identified a single fault candidate multiple times in the suspect fault		Minor	Closed (6/15/95)
69	8/30/94	BIT did not report an alarm when the waveform generator was faulted		Moderate	Closed

TDR #	Date	Description of TDR	Pre-DRR	Criticality	Status
70	8/30/94	BIT/FIT did not detect or isolate a map control failure		Moderate	Closed
71	8/30/94	FIT did not isolate a frequency select board failure		Moderate	Closed
72	8/30/94	BIT did not detect RRWDS alarm with board removed, but FIT isolated		Moderate	Closed (8/4/95)
73	8/30/94	BIT did not detect Rdr Trig alarm with board removed, but FIT isolated		Moderate	Open
74	8/30/94	BIT did not detect STTG alarm with board removed, but FIT isolated		Moderate	Closed
75a	8/30/94	BIT/FIT did not detect/isolate a faulty Preamp Switch in the Transmitter		Moderate	Closed
75b	8/30/94	BIT did not detect a faulty Preamp switch, but FIT isolated w/ TX RF ON		Moderate	Closed
75c	8/30/94	TX automatically shut OFF, FIT could not isolate faulty Preamp switch		Moderate	Closed
76	9/1/94	Excessive time to report an alarm, 19 minutes for Det Ch 1 Pulse		Moderate	Closed
77	9/1/94	Could not run FIT on Det CH 1 with Pulse Compressor board faulted		Moderate	Open
78	N/A	N/A			
79	9/7/94	LDC "PPI Link Down" cleared while link was still down , no link alarms		Moderate	Closed
80	9/7/94	FIT did not isolate a RDI failure with RDI board removed, FIT showed		Moderate	Closed
81	9/8/94	Major system software version was not updated from the 28JUN94 ACCS		SERIOUS	Closed (7/6/95)
82	9/8/94	Pedestal Enclosure 'B' alarms detected		Moderate	Closed (1/4/95)
83	9/9/94	Placing Drive #1 disconnect switch in the 'ON' position causes warm start		SERIOUS	Closed (1/4/95)
84	9/9/94	Neither drive motor would start with a single APG faulted		SERIOUS	Open
85	9/12/94	Error occurred during Data Extraction, resulting in a stoppage		Minor	Open (7/3/95)
86	9/13/94	A hardware extraction type 101 resulted in a warm start and system reset		SERIOUS	Closed (6/28/95)
87	9/13/94	Hardware extraction type 101 & 102 resulted in GeoMap HA's		SERIOUS	Closed (6/28/95)
88	9/13/94	Command to load APG offsets resulted in an error message		Minor	Closed (6/28/95)
89	9/15/94	Drive motor #2 would not start with the "Rotation Interlock Bypass" switch		Moderate	Closed
90	9/16/94	TMDT locked up after removing Loop Controller and commanding TX		Moderate	Open
91	9/16/94	LNA #8 damaged due to a failed Pulse Shape Sequencer		SERIOUS	Open
92	9/16/94	Search loss with STC end range change, Srch & Bcn lost with STC slope		SERIOUS	Closed (7/3/95)
93	10/5/94	The LDC PPI/RAPPI could not be resized to the default display		Minor	Open
94	10/5/94	Beacon video becomes offset from RAPPI by 3 degrees clockwise		Moderate	Open
95	10/5/94	Alarm threshold adjustments were required when LNA #8 was changed		Moderate	Open
96	10/5/94	ARP pulse to RRWDS is not aligned between 2 ACP positive pulses	X	SERIOUS	Open
97	10/5/94	Commanding sector 0 to STAC mode caused an STC HA, cleared in VIP		SERIOUS	Closed (7/3/95)
98	10/5/94	A non-7700 military emergency target is not processed as an emergency		SERIOUS	Closed (7/14/95)
99	10/5/94	CPU #8 and 9 indicated a HA, cold start restored CPU operation		SERIOUS	Open
100	10/5/94	RMS continuously displays HA for LDC #2 SIO port		Minor	Closed (6/28/95)
101	10/6/94	SRTQC targets are not output after switching from MAINT to OPER mode		Moderate	Closed (7/3/95)
102	10/14/94	ARSR-4 provides no indication of a faulty backup battery		SERIOUS	Closed

Table 1: OT&E Test Discrepancy Reports (May 23, 1994 through August 1, 1995)

Table 1: OT&E Test Discrepancy Reports (May 23, 1994 through August 1, 1995)					
TDR #	Date	Description of TDR	Pre-DRR	Criticality	Status
103	10/20/94	Backup battery mounting slot is misaligned		SERIOUS	Closed (12/15/94)
104	10/5/94	Faulty RRWDS video level from a defective RW board was not reported		Moderate	Open
105	9/14/94	ARSR-4 does not meet radar range and azimuth resolution requirements		Minor	Open
106	9/14/94	Targets are not resolved when separated by greater than minimum requirements	X	SERIOUS	Open
107	12/8/94	Contiguous Mode 3/A, C and Mode 2, C targets are not resolved		SERIOUS	Closed (6/28/95)
108	12/8/94	RMS menus do not update or contain missing information		SERIOUS	Closed (6/15/95)
109	12/8/94	Incorrect target readbacks on Menu 2.9.2 (Beacon Operational Test Targets)		Moderate	Closed (6/28/95)
110	12/8/94	Weather channel status incorrectly reported in WXCHST field		SERIOUS	Closed (6/15/95)
111	12/8/94	Data extraction file cannot be deleted through the RMS (Menu 7.1)		Minor	Closed (7/3/95)
112	12/8/94	False SPI indications for targets with the F1 of another target in the SPI position		SERIOUS	Closed (7/14/95)
113	12/8/94	False Emergency Indication on the LDC with a Mode 2 of 7700		Moderate	Open
114	12/8/94	ARSR-4 did not recover from a short term power loss (< 15 seconds)		SERIOUS	Closed - See TDR 151
115	12/8/94	Complete loss of beacon video on the LDC, channel switch required to recover		Moderate	Closed (7/14/95)
116	12/8/94	Cold starts exceed the 180 second requirement		Moderate	Closed (7/6/95)
117	12/8/94	Automatic fault reset did not work for alarms 5179 and 5279 (DSR/CTS Down)		Moderate	Closed (6/28/95)
118	12/8/94	With PE #1 set, alarms 4288/4205 persist and synchronizer 'B' switches to UA-E		Moderate	Open
119	12/8/94	PE is not consistently output on RAPPI, 8 or more hits are seen in detection video		Moderate	Open
120	12/11/94	ARSR-4 sends 'Clear Interface' commands on the ISM interface bus		Minor	Closed (7/6/95)
121	12/11/94	ARSR-4 requests Ch 'A' status using a Ch 'B' command and vice versa		Minor	Closed (7/6/95)
122	12/11/94	ISM/ARSR-4 Interface lockups require cable removal to restore interface		SERIOUS	Closed (7/6/95)
123	12/11/94	BCOL field of the HOST status message does not function	X	SERIOUS	Open
124	3/1/95	Incorrect beacon altitudes (Invalid negative altitudes)		SERIOUS	Closed (7/6/95)
125	3/1/95	BRTQC not flagged as RTQC and reported at incorrect range/azimuth		SERIOUS	Closed
126	3/1/95	Mode S status message fields are not functioning		Moderate	Open
127	3/1/95	Mode S ICD and TIBS do not match		Moderate	Open
128	3/1/95	Software version numbers are decrementing		SERIOUS	Closed (7/6/95)
129	3/24/95	Short Term Power Loss Recovery		SERIOUS	Closed - See TDR 151
130	3/24/95	Beacon reports offset in azimuth by thirty degrees		SERIOUS	Closed
131	3/24/95	All beacon reports aligned along one azimuth	X	SERIOUS	Open
132	3/24/95	Inability to switch SIO 9 in as a spare		SERIOUS	Closed (6/28/95)
133	3/24/95	SIO availability / alarm reporting anomalies		SERIOUS	Closed (7/6/95)
134	4/26/95	Data Loss/TX turned off coincident with a reported CPU Loss/Warm start		SERIOUS	Closed (7/21/95)
135	4/26/95	Warm starts while attempting Data Extraction Quick Look		SERIOUS	Closed (6/15/95)
136	4/26/95	Nine second data loss coincident with a CPU Loss/Warm start		SERIOUS	Closed (7/21/95)
137	4/26/95	Unable to bring back STBY CPU with a commanded warm start	X	SERIOUS	Open

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TDR #	Date	Description of TDR	Pre-DRR	Criticality	Status
138	4/26/95	Consecutive automatic cold starts with no BIT alarms shown on RMS	X	SERIOUS	Open
139	4/26/95	BRTQCA bit in HOST status message not set when BRTQC out of tolerance		SERIOUS	Open
140	6/15/95	Water leaking in transmitter room		SERIOUS	Retest
141	6/15/95	Water found in 2:1:8 splitter in transmitter		SERIOUS	Open
142	6/15/95	Frequency Transition hard alarms appearing after a cold start		SERIOUS	Open
143	6/15/95	Multiple, automatic warm starts		SERIOUS	Open
144	6/15/95	Inconsistent alarm indications		SERIOUS	Open
145	6/15/95	Incorrect SRTQC bit operation in the HOST status message		SERIOUS	Closed (6/28/95)
146	6/15/95	ARSR-4 system crashes coincident with global status polling on MPS Interface		SERIOUS	Closed (7/14/95)
147	6/15/95	Incorrect M4ALA and M4INOR bit operation in HOST and SOCC status messages		Minor	Open
148	6/15/95	Incorrect SPSTAT bit operation in SOCC status message		Minor	Open
149	7/31/95	Different display of weather on DARC vs. NAS	X	SERIOUS	Open
150	7/31/95	Inability to load STC for one sector in quadrants 2, 3, or 4		Moderate	Open
151	7/31/95	Summary of Power Loss TDRs	X	SERIOUS	Open
152	7/31/95	Low System Reliability	X	SERIOUS	Open
153	7/31/95	Low System Maintainability	X	SERIOUS	Open
154	7/31/95	Lack of system Configuration Control	X	SERIOUS	Open

APPENDIX B

IRES PROGRAM DESCRIPTIONS

IRES PROGRAM DESCRIPTIONS

This appendix contains a brief description of the IRES programs used during ARSR-4 OT&E. The descriptions were extracted from IRES user's manual. A more detailed description of the programs can be found in the user's manual.

CmpDelay	Compute Report Delay	Analysis

CmpDelay computes surveillance report delays assuming the report time is the actual time output from the radar system, and a report type exists that has zero delay (i.e., ASR-9 Sector Marks).

ColRB	Collimate Radar/Beacon	Analysis

ColRB produces range, azimuth or height collimation histograms. The collimation histogram shows the frequency of position differences between:

- both surveillance types (radar and beacon),
- one surveillance and one reference, or
- both reference types (to establish confidence in the reference used).

Each histogram shows the mean and standard deviation of position difference.

CopyLLA	Copy Lat/Long/Altitude data into PCS	Reformat

CopyLLA reformats ASCII Latitude, Longitude, and Altitude position data into PCS-2 Reference reports, performing a coordinate transform to the position of the radar antenna. This is required before merging reference data with the tracked reports of the flight test aircraft. The coordinate transform conforms to the WGS-84 (NAD-83) earth model.

CountPCS	Count PCS surveillance reports	Summary

CountPCS counts the number of each type of surveillance report in the PCS file. For radar reports (RC and RO), the number of each Quality and Confidence pair is counted. For beacon reports (RB and BO), the number of each beacon mode (3/A, 2, and C) validation is counted.

CountTrk	Count TQA qualified reports	Summary

CountTrk counts the number of each surveillance report type in the qualified tracked reports file by track quality. Also counts tracks by track criteria. The track qualities are assigned by Qualify. This is summary step in the Track Quality Assessment (TQA) process, following Track, Qualify and PlotTQA.

Delay	Delay Histograms	Analysis

Delay plots a histogram showing the distribution of surveillance report delays relative to the boresight of the radar antenna. The recorded file must contain a report type that contains antenna azimuth at time of recording. ASR-9 sector marks or artificial sector marks (e.g., generated by BEXR) can be used. The Delay histogram bars are color coded by report type (Radar, Beacon, Correlated, Reinforced).

Filter	Filter PCS surveillance reports	Utility

Filter extracts surveillance reports that contain (or fail to contain) the values entered into filter menus. The filter menus contains a range of values for the fields that are continuous (e.g., range, azimuth, time), a group of values for fields that have a list of values (e.g., Mode 3/A codes) or yes/no (on/off) switches for fields that are enumerated or boolean in nature (e.g., Report ID, Quality, Confidence, Code Validation, flags). Filter can copy the reports that meet the filter menus into a PASS file and/or the reports that do not meet the filter into a FAIL file.

HgtAcc	Height Accuracy Histograms	Utility

HgtAcc produces a height accuracy versus range histogram that applies a barometric altitude correction to the beacon altitude before comparing with primary radar height. Two altitude corrections ("D" value) define a line from the beginning to the end of a track and a linear interpolation applies corrections at any range along the track.

MergePCS	Merge surveillance and reference files	Utility

MergePCS consolidates reference reports from an independent high precision tracker with selected tracked reports from the radar under test. This is used when an independent position source (i.e., GPS, Nike) is supplying highly accurate positional information of a flight test aircraft.

PlotElev	Plot Elevation angle versus azimuth	Utility

PlotElev displays an elevation versus azimuth plot of the surveillance reports.

PlotPCS	Plot PCS surveillance reports	Utility

PlotPCS displays a PPI plot of the surveillance reports in a PCS file. You may "zoom in" to look at a small area in detail, change color coding, and pause and clear the PPI area.

PlotPD	Percentage of Detection Histogram	Analysis

PlotPD displays percentage of detection histograms of a single test aircraft. The histograms show how well the track was detected from zero to maximum range while traveling inbound and outbound. The following detection histograms are available:

- Radar Correlated (RC) reports only,
- All radar reports EXCEPT Quality 0 Radar Only (RO) reports,
- All radar reports (RC, RO, and Radar/Beacon),
- Beacon reports (RB, and Beacon Only),
- Combined Inbound/Outbound Radar and Beacon reports.

The histograms may be shown smoothed over three range bins using a sliding window averaging process where the detection of one range bin is influenced by the detection of the previous and next range bin.

PlotRes	Plot Resolution	Analysis

PlotRes produces a resolution histogram of the radar system. To determine resolution, truth data is used to determine the actual separation of two flight test aircraft. The presence of two target reports mean the two aircraft were resolved, while one report means the two aircraft were not resolved. The histogram shows how often the both aircraft were seen and at what separation. An independent reference (i.e., GPS, Nike) position yield best results.

PlotRHI	Plot Range versus Height Indicator	Analysis

PlotRHI displays an Range Height Indicator (RHI) plot of beacon Mode C altitude or radar height versus range.

PlotScan	Plot Scan summaries	Utility

PlotScan displays a graph of the number of report (i.e., radar, beacon, RTQC, Status, etc.) versus scan. The graph shows report loading over time and can be used to identify capacity and data dropout problems.

PlotTQA	Plot TQA tracks	Analysis

PlotTQA displays PPI plots of individual target of opportunity tracks. This is the third step in the Track Quality Assessment (TQA) process, following Track and Qualify.

PlotWX	Plot Weather Map	Utility

PlotWX displays a colored PPI plot of a weather map. The colors show the weather level contained in the report. The meanings of the levels are determined by the radar system and can be made consistent by PrepWx.

PrepPCS	Prepare PCS-2 surveillance reports	Utility

PrepPCS prepares a PCS surveillance file for analysis by IRES programs by placing the reports in strict range/azimuth order and combining multiple reports from a single target into a consolidated report block. Most IRES analysis programs require the output of PrepPCS, display only applications do not require this step.

PrepWx	Prepare PCS-2 weather reports	Utility

PrepWx prepares a PCS weather file from a CD-1/2 source for plotting by PlotWx by placing the interlaced weather messages in azimuth order for a complete map. CD weather messages are output:

- two or three levels per weather map,
- course detail or fine detail (high or low Interval)
- every scan or alternating scans (Interlace),
- over one, two, or three scans for each level.

A complete weather map requires anywhere from 2 scans to 18 scans.

Qualify	Qualify tracked reports	Analysis

Qualify determines the track quality of target of opportunity tracks using up to 26 true and false track criteria input from an ASCII file. This is the second step in the Track Quality Assessment (TQA) process, following Track and preceding PlotTQA.

Record	Record CD format reports	Data Collection

Record provides the means of recording CD format surveillance and weather reports. The program reformats the CD message into PCS-2 format and displays the reports being recorded in a PPI plot.

RecRMS	Records RMS screens	Data Collection

RecRMS is a terminal emulator for the local Remote Maintenance System terminal connected to the radar system. It allows commands to the RMS to be captured and played back to RMS and to capture screens from RMS in pure ASCII form. PC cursor keystrokes generate an ANSI escape sequence to send to RMS, and ANSI escape sequence received from RMS are translated for the PC display. The RMS may be connected directly or over a modem, with built-in dialing support.

Select	Selective Tracker	Utility

Select tracks one or two flight test aircraft. Mode 3/A beacon code(s) are used to initiate track. Once initiated, the tracking algorithm will continue update the predicted position using radar/beacon, beacon only or radar only reports.

ShowPCS	Show PCS surveillance reports	Utility

ShowPCS displays the contents of PCS surveillance reports in an easy to understand fashion. Some simple searching capabilities are built in to help you find specific reports.

ShowStat	Show Status contents	Utility

ShowStat shows the contents of each status message in a surveillance report file along with the meaning and value of each status in an easy to understand form. A pure ASCII status definition file contains a description of each status by word, bit position and length, a mnemonic, type, and text to be displayed for each status condition. Any pure ASCII text editor or word processor can be used to modify the status definition file.

SortTrk	Sort Tracked reports	Utility

SortTrk ordered tracked reports from track by track number, putting all reports of a track in sequential order. This is part of the Track Quality Assessment (TQA) Track process and is automatically started, you would need to run this only if there was a disk problem or insufficient disk space to perform the sorting.

SplitCnt	Split Count summary	Utility

SplitCnt counts splits in three ways: the number of reports flagged by PrepPCS as splits, the number of consolidated report blocks containing one or more splits, and the number of consolidated report blocks containing a beacon report and one or more splits.

Track	Track all targets	Utility

Track performs an alpha-beta tracking on all surveillance reports in the prepared file. Tracks are initiated on any eligible radar or beacon report, and updated on either type of eligible report. Report eligibility determines whether a report can initiate track, or update a track, and is controlled by menu selection. This is the first step of the Track Quality Assessment (TQA) process.

APPENDIX C

ARSR-4 AND ARSR-3 QARS RESULTS

ARSR-4 AND ARSR-3 QARS RESULTS

Parameter	Fail	June 14,1995 ARSR-3	June 14,1995 ARSR-4	June 15,1995 ARSR-3	June 15,1995 ARSR-4
Beacon					
Scans		8798	5915	7844	5957
Blip/Scan	< 96%	99.1	98.2	98.5	99.1
Sch-Reinfor	< 85%	92.0	95.2	89.4	94.3
Az Splits	> .1%	.0	.2	.0	.2
Rng Splits	> .1%	.0	.0	.0	.1
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.1	.0	.0
Mode 3/A Rel	< 98%	99.5	99.3	99.5	99.7
Mode 3/A Val	< 98%	99.1	98.6	99.2	99.5
Mode C Rel	< 97%	98.8	99.2	99.0	99.5
Mode C Val	< 95%	97.6	97.2	98.0	98.4
Mode C Scans		8694	5788	7683	5882
Rng Dev	> 0/1	0/1	0/1	0/1	0/1
Az Dev	> 2.0	2.21	1.89	2.16	1.88
Log/Nml					
Scans		917	5915	867	5957
Blip/Scan	< 85%	89.8	93.8	88.9	93.9
Az-Split	> .2%	.0	.2	.0	.1
Rng-Split	> 3%	.0	.1	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	+1.2	-0.1	+0.8	+0.1
#1 Pct Rel	< 90%	100.0	100.0	100.0	100.0
Total Tracks		99	91	91	84

		June 16,1995		June 19,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		9603	7511	7474	6410
Blip/Scan	< 96%	98.5	98.2	99.1	99.3
Sch-Reinfor	< 85%	91.9	94.2	90.2	92.9
Az Splits	> .1%	.0	.1	.0	.1
Rng Splits	> .1%	.0	.1	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.2	.0	.2
Mode 3/A Rel	< 98%	99.1	98.8	99.2	99.2
Mode 3/A Val	< 98%	98.5	98.0	98.7	98.2
Mode C Rel	< 97%	98.4	98.8	99.0	99.2
Mode C Val	< 95%	97.0	97.0	97.8	97.5
Mode C Scans		9374	7208	7364	6267
Rng Dev	> 0/1	0/1	0/0	0/0	0/0
Az Dev	> 2.0	2.19	1.83	2.12	1.79
Log/Nml					
Scans		679	7511	825	6410
Blip/Scan	< 85%	92.3	92.6	80.7	92.5
Az-Split	> .2%	.0	.1	.0	.1
Rng-Split	> 3%	.0	.1	.0	.1
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.2	+0.4	-0.2	-0.0
#1 Pct Rel	< 90%	98.0	96.0	100.0	98.0
Total Tracks		100	100	104	102

		June 20,1995		June 21,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		8656	7233	8610	6224
Blip/Scan	< 96%	99.1	99.5	98.8	99.0
Sch-Reinfor	< 85%	90.0	96.6	89.9	98.0
Az Splits	> .1%	.0	.2	.0	.0
Rng Splits	> .1%	.0	.2	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.0	.0	.1
Mode 3/A Rel	< 98%	99.4	99.5	99.6	99.4
Mode 3/A Val	< 98%	99.1	99.0	99.2	98.8
Mode C Rel	< 97%	98.7	99.4	99.1	99.1
Mode C Val	< 95%	97.4	98.1	98.1	97.8
Mode C Scans		8525	7181	8454	6100
Rng Dev	> 0/1	0/1	0/1	0/1	0/0
Az Dev	> 2.0	2.11	1.77	2.00	1.68
Log/Nml					
Scans		787	7233	764	6224
Blip/Scan	< 85%	85.8	96.4	88.2	97.3
Az-Split	> .2%	.0	.1	.0	.1
Rng-Split	> 3%	.0	.0	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.7	-0.1	-0.9	-0.3
#1 Pct Rel	< 90%	98.0	100.0	100.0	100.0
Total Tracks		105	106	105	88

		June 22,1995		June 23,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		8237	5474	7638	5697
Blip/Scan	< 96%	99.1	99.4	99.4	99.7
Sch-Reinfor	< 85%	91.6	98.2	92.3	97.8
Az Splits	> .1%	.0	.0	.0	.0
Rng Splits	> .1%	.0	.0	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.0	.0	.1
Mode 3/A Rel	< 98%	99.7	99.2	99.9	99.3
Mode 3/A Val	< 98%	99.3	98.7	99.6	98.9
Mode C Rel	< 97%	99.3	98.8	99.4	99.1
Mode C Val	< 95%	98.3	97.0	98.7	98.0
Mode C Scans		8109	5413	7572	5636
Rng Dev	> 0/1	0/1	0/0	0/1	0/1
Az Dev	> 2.0	2.05	1.73	2.07	1.73
Log/Nml					
Scans		862	5474	1097	5697
Blip/Scan	< 85%	88.9	97.9	90.8	97.7
Az-Split	> .2%	.0	.1	.0	.1
Rng-Split	> 3%	.0	.0	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.4	-0.1	-0.1	-0.3
#1 Pct Rel	< 90%	100.0	96.0	98.0	98.0
Total Tracks		103	88	108	92

		June 26,1995		June 27,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		9050	6643	8267	6407
Blip/Scan	< 96%	98.9	99.6	99.5	99.6
Sch-Reinfor	< 85%	91.4	97.6	92.8	97.0
Az Splits	> .1%	.0	.0	.0	.1
Rng Splits	> .1%	.0	.0	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.2	.0	.1
Mode 3/A Rel	< 98%	99.5	99.0	99.7	99.6
Mode 3/A Val	< 98%	98.9	98.3	99.3	99.3
Mode C Rel	< 97%	98.8	98.8	99.2	99.4
Mode C Val	< 95%	97.8	97.4	98.1	98.3
Mode C Scans		8909	6552	8225	6378
Rng Dev	> 0/1	0/1	0/1	0/1	0/0
Az Dev	> 2.0	2.02	1.79	1.97	1.71
Log/Nml					
Scans		1021	6643	964	6407
Blip/Scan	< 85%	86.4	97.3	91.3	96.6
Az-Split	> .2%	.0	.1	.0	.2
Rng-Split	> 3%	.0	.1	.0	.1
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.1	-0.2	+0.1	+0.0
#1 Pct Rel	< 90%	100.0	100.0	100.0	98.0
Total Tracks		100	94	89	90

		June 28,1995		June 29,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		8557	7286	7702	5741
Blip/Scan	< 96%	98.6	98.8	99.0	99.0
Sch-Reinfor	< 85%	89.4	96.8	89.5	96.7
Az Splits	> .1%	.0	.1	.0	.0
Rng Splits	> .1%	.0	.0	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.2	.0	.1
Mode 3/A Rel	< 98%	99.6	99.3	99.4	99.4
Mode 3/A Val	< 98%	99.1	98.8	98.9	98.9
Mode C Rel	< 97%	98.8	99.1	98.8	99.2
Mode C Val	< 95%	97.8	97.7	97.5	97.6
Mode C Scans		8412	7186	7597	5661
Rng Dev	> 0/1	0/1	0/1	0/1	0/0
Az Dev	> 2.0	2.04	1.78	1.98	1.79
Log/Nml					
Scans		916	7286	697	5741
Blip/Scan	< 85%	82.8	96.3	82.3	96.2
Az-Split	> .2%	.0	.1	.0	.0
Rng-Split	> 3%	.0	.1	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	+0.3	+0.4	-0.4	-0.0
#1 Pct Rel	< 90%	98.0	96.0	100.0	100.0
Total Tracks		107	105	87	83

		July 07,1995		July 10,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		8003	6010	9228	6386
Blip/Scan	< 96%	98.2	98.6	98.9	99.4
Sch-Reinfor	< 85%	88.1	95.1	91.1	96.0
Az Splits	> .1%	.0	.2	.0	.3
Rng Splits	> .1%	.0	.1	.2	.3
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.1	.0	.1
Mode 3/A Rel	< 98%	99.6	99.4	99.5	99.2
Mode 3/A Val	< 98%	98.8	98.3	98.7	98.2
Mode C Rel	< 97%	98.5	98.8	98.4	98.8
Mode C Val	< 95%	97.0	96.8	97.0	97.2
Mode C Scans		7779	5824	9026	6258
Rng Dev	> 0/1	0/1	0/1	0/1	0/1
Az Dev	> 2.0	2.00	1.75	2.05	1.81
Log/Nml					
Scans		691	6010	925	6386
Blip/Scan	< 85%	78.5	94.3	85.7	95.6
Az-Split	> .2%	.0	.0	.0	.2
Rng-Split	> 3%	.0	.0	.0	.1
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	+0.1	-0.1	+0.0	+0.0
#1 Pct Rel	< 90%	100.0	98.0	98.0	96.0
Total Tracks		101	93	105	100

Parameter	Fail	July 11,1995 ARSR-3	July 11,1995 ARSR-4	July 12,1995 ARSR-3	July 12,1995 ARSR-4
Beacon					
Scans		8257	6503	8544	5632
Blip/Scan	< 96%	98.6	98.6	98.6	98.2
Sch-Reinfor	< 85%	90.8	93.8	90.0	95.0
Az Splits	> .1%	.0	.0	.0	.0
Rng Splits	> .1%	.0	.0	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.1	.0	.1
Mode 3/A Rel	< 98%	99.6	99.4	99.6	99.1
Mode 3/A Val	< 98%	99.3	98.9	99.1	98.6
Mode C Rel	< 97%	98.7	99.1	99.1	99.1
Mode C Val	< 95%	97.4	97.4	98.0	97.7
Mode C Scans		8098	6338	8350	5474
Rng Dev	> 0/1	0/1	0/1	0/1	0/1
Az Dev	> 2.0	2.54	1.71	2.07	1.82
Log/Nml					
Scans		718	6503	656	5632
Blip/Scan	< 85%	84.4	92.8	82.0	94.3
Az-Split	> .2%	.0	.1	.1	.0
Rng-Split	> 3%	.0	.1	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.9	-0.1	-0.4	+0.0
#1 Pct Rel	< 90%	100.0	100.0	100.0	98.0
Total Tracks		101	99	100	90

		July 13,1995		July 18,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		9413	7861	7252	6563
Blip/Scan	< 96%	98.7	99.3	99.2	99.4
Sch-Reinfor	< 85%	91.2	96.8	89.9	97.3
Az Splits	> .1%	.0	.2	.0	.1
Rng Splits	> .1%	.0	.1	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.1	.0	.0
Mode 3/A Rel	< 98%	99.1	99.4	99.5	99.4
Mode 3/A Val	< 98%	98.5	98.7	99.3	98.9
Mode C Rel	< 97%	98.5	99.1	98.8	99.0
Mode C Val	< 95%	97.2	97.4	97.8	97.6
Mode C Scans		9231	7764	7121	6453
Rng Dev	> 0/1	0/1	0/0	0/1	0/1
Az Dev	> 2.0	1.95	1.78	2.08	1.79
Log/Nml					
Scans		934	7861	688	6563
Blip/Scan	< 85%	80.6	96.6	85.3	97.0
Az-Split	> .2%	.0	.1	.0	.2
Rng-Split	> 3%	.1	.1	.0	.1
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.5	-0.2	+0.1	-0.2
#1 Pct Rel	< 90%	94.0	96.0	100.0	100.0
Total Tracks		113	113	94	95

		July 19,1995		July 20,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		8907	6122	7343	5703
Blip/Scan	< 96%	98.7	99.3	99.0	99.6
Sch-Reinfor	< 85%	90.6	96.6	89.1	96.8
Az Splits	> .1%	.0	.0	.0	.0
Rng Splits	> .1%	.0	.0	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.0	.0	.2
Mode 3/A Rel	< 98%	99.6	99.5	99.7	99.4
Mode 3/A Val	< 98%	99.2	99.1	99.3	99.0
Mode C Rel	< 97%	98.9	99.3	99.0	99.2
Mode C Val	< 95%	97.8	97.8	98.1	97.9
Mode C Scans		8764	6068	7175	5671
Rng Dev	> 0/1	0/1	0/0	0/1	0/1
Az Dev	> 2.0	2.05	1.69	1.94	1.62
Log/Nml					
Scans		766	6122	717	5703
Blip/Scan	< 85%	89.5	96.2	82.7	96.7
Az-Split	> .2%	.0	.1	.0	.1
Rng-Split	> 3%	.0	.1	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	+0.0	-0.3	-0.0	-0.1
#1 Pct Rel	< 90%	100.0	100.0	100.0	100.0
Total Tracks		100	93	88	81

		July 26,1995		July 31,1995	
Parameter	Fail	ARSR-3	ARSR-4	ARSR-3	ARSR-4
Beacon					
Scans		7874	6103	7924	5230
Blip/Scan	< 96%	99.0	99.5	99.2	99.7
Sch-Reinfor	< 85%	90.0	98.1	87.5	96.5
Az Splits	> .1%	.0	.0	.0	.2
Rng Splits	> .1%	.0	.0	.0	.1
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	1.1	.0	.0	.1
Mode 3/A Rel	< 98%	99.7	99.5	99.4	99.4
Mode 3/A Val	< 98%	99.2	99.0	99.0	99.1
Mode C Rel	< 97%	98.9	99.3	99.0	99.4
Mode C Val	< 95%	98.1	98.2	97.6	97.3
Mode C Scans		7668	6068	7842	5192
Rng Dev	> 0/1	0/1	0/0	0/1	0/0
Az Dev	> 2.0	2.09	1.70	2.05	1.69
Log/Nml					
Scans		816	6103	779	5230
Blip/Scan	< 85%	85.7	98.0	81.8	96.4
Az-Split	> .2%	.0	.1	.0	.3
Rng-Split	> 3%	.0	.1	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	+0.2	-0.0	-0.2	-0.2
#1 Pct Rel	< 90%	98.0	100.0	100.0	100.0
Total Tracks		94	84	83	76

Parameter	Fail	August 1, 1995 ARSR-3	August 1, 1995 ARSR-4	August 2, 1995 ARSR-3	August 2, 1995 ARSR-4
Beacon					
Scans		8136	5296	8201	4856
Blip/Scan	< 96%	99.3	99.7	99.5	99.4
Sch-Reinfor	< 85%	88.5	97.1	87.6	97.0
Az Splits	> .1%	.0	.1	.0	.3
Rng Splits	> .1%	.0	.0	.0	.1
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.1	.0	.3
Mode 3/A Rel	< 98%	99.7	99.6	99.4	99.3
Mode 3/A Val	< 98%	99.2	99.2	99.0	98.8
Mode C Rel	< 97%	99.1	99.4	98.9	99.0
Mode C Val	< 95%	98.2	98.1	98.2	97.6
Mode C Scans		8066	5260	8157	4816
Rng Dev	> 0/1	0/1	0/1	0/1	0/0
Az Dev	> 2.0	2.00	1.70	2.07	1.79
Log/Nml					
Scans		928	5296	1106	4856
Blip/Scan	< 85%	83.0	97.0	76.9	96.6
Az-Split	> .2%	.0	.2	.0	.3
Rng-Split	> 3%	.1	.0	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.0	-0.1	+0.3	+0.0
#1 Pct Rel	< 90%	98.0	98.0	100.0	100.0
Total Tracks		88	79	94	81

Parameter	Fail	August 3, 1995 ARSR-3	August 3, 1995 ARSR-4	August 4, 1995 ARSR-3	August 4, 1995 ARSR-4
Beacon					
Scans		8166	5054	8266	5293
Blip/Scan	< 96%	99.1	99.1	99.0	98.7
Sch-Reinfor	< 85%	89.3	96.2	87.6	94.8
Az Splits	> .1%	.0	.1	.0	.1
Rng Splits	> .1%	.0	.1	.0	.0
Ring-Around	> .5%	.0	.0	.0	.0
Reflections	> .2%	.0	.0	.0	.0
Code Zeroes	> .5%	.0	.1	.0	.1
Mode 3/A Rel	< 98%	99.7	99.5	99.4	99.5
Mode 3/A Val	< 98%	99.5	99.1	99.1	98.6
Mode C Rel	< 97%	99.5	99.1	99.0	99.3
Mode C Val	< 95%	98.6	98.4	97.9	97.5
Mode C Scans		8030	4962	8126	5178
Rng Dev	> 0/1	0/1	0/0	0/1	0/1
Az Dev	> 2.0	2.02	1.77	1.98	1.78
Log/Nml					
Scans		857	5054	857	5293
Blip/Scan	< 85%	85.2	95.5	80.7	94.2
Az-Split	> .2%	.0	.1	.0	.2
Rng-Split	> 3%	.1	.0	.0	.0
PE Verification					
#1 Rng Error	> 0/1	+0/0	-0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.4	-0.0	-0.4	+0.1
#1 Pct Rel	< 90%	98.0	98.0	100.0	100.0
Total Tracks		85	78	88	86

		August 7, 1995	
Parameter	Fail	ARSR-3	ARSR-4
Beacon			
Scans		8313	5928
Blip/Scan	< 96%	99.1	99.5
Sch-Reinfor	< 85%	90.0	96.8
Az Splits	> .1%	.0	.2
Rng Splits	> .1%	.0	.1
Ring-Around	> .5%	.0	.0
Reflections	> .2%	.0	.0
Code Zeroes	> .5%	.0	.2
Mode 3/A Rel	< 98%	99.5	99.2
Mode 3/A Val	< 98%	99.1	98.3
Mode C Rel	< 97%	99.2	98.9
Mode C Val	< 95%	98.1	97.3
Mode C Scans		8201	5858
Rng Dev	> 0/1	0/1	0/1
Az Dev	> 2.0	2.02	1.74
Log/Nml			
Scans		539	5928
Blip/Scan	< 85%	89.4	96.6
Az-Split	> .2%	.0	.0
Rng-Split	> 3%	.0	.0
PE Verification			
#1 Rng Error	> 0/1	+0/0	-0/1
#1 Az Error	> 2.0	-0.1	-0.1
#1 Pct Rel	< 90%	100.0	100.0
Total Tracks		93	88

APPENDIX D

OPERATIONAL TEST QUESTIONNAIRES

OPERATIONAL TEST QUESTIONNAIRES

Questionnaires were developed to obtain input from air traffic controllers concerning the suitability and effectiveness of the ARSR-4 operating in NAS. Controllers participated in the development of the questionnaires as well as responding to the questions. This appendix lists the questions and corresponding controller responses. Controller Yes, No, or Not Observed, responses to each question are included along with any additional comments. The unshaded portions of the tables correspond to responses from precertification tests and the shaded portions from postcertification tests.

Does the ARSR 4/ARTCC interface provide the following?

1. The capability to identify, track and control aircraft in your sector or surveillance area?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			
G	X			
H	X			
I	X			
F	X			
J	X			
K	X			
L	X			
M	X			
N	X			
O	X			
P	X			
Q	X			
M	X			
R	X			

2. Observable information on the controller displays? FDB/LDB, MODE C?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			
G	X			
H	X			
I	X			
F	X			
J	X			
K	X			
L	X			
M	X			
N	X			
O	X			
P	X			
Q	X			
M	X			
R	X			

3. The display of weather information?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D	X			
E		X		
F		X		
G	X			
H			X	
I	X			Some false weather
F			X	
J			X	
K	X			
L			X	
M	X			Erroneous
N			X	
O			X	
P			X	
Q	X			
M	X			
R	X			Erroneous

4. The capability to allow you to provide required air traffic services?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			
G	X			
H	X			
I	X			
F	X			
J	X			
K	X			
L	X			
M	X			
N	X			
O	X			
P	X			
Q	X			
M	X			
R	X			

5. Auto Acquisition from Non Arts Facilities?

Controller	Yes	No	Not Observed	Comments
A			X	
B			X	
C			X	
D			X	
E			X	
F			X	
G			X	
H			X	
I			X	
F			X	
J			X	
K			X	
L			X	
M			X	
N			X	
O			X	
P			X	
Q			X	
M			X	
R			X	

6. Aircraft in Coast Track?

Controller	Yes	No	Not Observed	Comments
A			X	
B			X	
C			X	
D			X	
E			X	
F			X	
G			X	
H			X	
I			X	
F			X	
J			X	
K	X			vandy11 @ approx 1615z over jki went into coast track
L			X	
M	X			
N			X	
O			X	
P			X	
Q	X			
M	X			
R	X			

7. Did areas of known poor Radar coverage improve with the ARSR-4 system?

Controller	Better	Worse	Same	Comments
A			X	
B	X			
C			X	
D			X	
E			X	
F			X	
G	X			
H			X	
I	X			
F			X	
J			X	
K			X	
L				
M	X			
N	X			
O			X	
P	X			
Q	X			
M			X	
R				

8. Did you observe limited data blocks and full data blocks in areas and at times you should have?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			
G	X			
H	X			
I	X			
F	X			
J	X			
K		X		vandy11 @ approx 1615z over lji went into a coast track
L		X		
M	X			
N	X			
O	X			
P	X			
Q	X			
M	X			
R	X			

PRIMARY RADAR COVERAGE

1. Did you observe targets in all 4 quadrants of the radar coverage envelope (360 degrees)?

Controller	Yes	No	Not Observed	Comments
G	X			
H			X	
I			X	
F			X	
J	X			
K			X	
L	X			
M			X	
N				
O			X	
P			X	
Q	X			
M	X			
R	X			

2. Did you observe targets at different ranges (5-250 NM) from the radar site?

Controller	Yes	No	Not Observed	Comments
G			X	
H	X			
I			X	
F			X	
J			X	
K		X		Range set @ 75 NM
L			X	
M		X		Range restricted
N			X	
O			X	
P			X	
Q	X			
M		X		RSB Limitations
R	X			

3. Did you observe altitude readout information at varying heights (up to 100,000 feet or the maximum altitude capability of the test aircraft) throughout the coverage area?

Controller	Yes	No	Not Observed	Comments
G			X	
H	X			
I			X	
F			X	
J			X	
K		X		Alt limit 000-242
L			X	
M		X		Altitude restricted
N			X	
O			X	
P			X	
Q	X			
M		X		Altitude Limitations
R	X			

4. Did you observe any holes (loss of target areas) in the radar coverage area?

Controller	Yes	No	Not Observed	Comments
G			X	
H	X			
I			X	
F			X	
J			X	
K	X			
L			X	
M	X			wedge
N			X	
O			X	
P			X	
Q	X			
M	X			wedge
R		X		

5. How does the radar coverage of the ARSR-4 compare to the radar coverage that was replaced by the ARSR-4?

Controller	Yes	No	Not Observed	Comments
G			X	
H			X	
I			X	
F			X	
J			X	
K			X	About the same coverage
L	X			
M			X	
N			X	
O			X	
P			X	
Q			X	
M		X		
R			X	

PRIMARY RADAR TARGET DETECTION

1. Did you observe primary targets of varying speeds at different altitude and ranges in the areas listed below?

a. Clear Areas (No Clutter)

Controller	Yes	No	Not Observed	Comments
G			X	
H			X	
I			X	
F			X	
J			X	
K			X	
L			X	
M		X		
N			X	
O			X	
P			X	
Q			X	
M		X		Altitudes unknown
R			X	

b. Clutter areas (sea, terrain, precipitation)

Controller	Yes	No	Not Observed	Comments
G			X	
H			X	
I			X	
F			X	
J			X	
K			X	
L			X	
M		X		
N			X	
O			X	
P			X	
Q			X	
M		X		Altitudes unknown
R			X	

2. Could you track primary targets through areas of clutter?

Controller	Yes	No	Not Observed	Comments
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		Didn't have the opportunity
L			X	
M	X			
N			X	
O			X	
P			X	
Q			X	
M	X			
R			X	

3. Did you observe primary targets of different sizes at different altitudes and ranges in the areas listed below?

a. Clear

Controller	Yes	No	Not Observed	Comments
G			X	
H			X	
I			X	
F			X	
J			X	
K			X	
L			X	
M		X		
N			X	
O			X	
P			X	
Q			X	
M		X		Altitudes unknown
R	X			

b. Clutter

Controller	Yes	No	Not Observed	Comments
G			X	
H			X	
I			X	
F			X	
J			X	
K			X	
L			X	
M		X		
N			X	
O			X	
P			X	
Q			X	
M		X		Altitudes unknown
R			X	

4. Was primary target detection better with the ARSR-4 system than with your present system? Please explain.

Controller	Yes	No	Not Observed	Comments
G			X	
H			X	
I			X	
F			X	
J			X	
K				The ARSR-4 seems comparable with our current system
L			X	
M			X	
N			X	
O			X	
P			X	
Q			X	
M			X	
R			X	

PRIMARY RADAR FALSE ALARM RATE

1. Did you observe the presence of false targets?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C	X			
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M		X		
N			X	
O			X	
P			X	
Q			X	
M		X		
R	X			

2. Could you differentiate false targets from real targets?

Controller	Yes	No	Not Observed	Comments
A			X	
B		X		
C	X			
D		X		
E			X	
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M	X			
N			X	
O			X	
P			X	
Q		X		
M			X	
R	X			

3. Could you determine what the false target was reflected from?

Controller	Yes	No	Not Observed	Comments
A			X	
B		X		
C		X		
D		X		
E			X	
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M		X		
N			X	
O			X	
P			X	
Q		X		
M			X	
R	X			Sometimes

4. Did you observe a large number of false targets?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M	X			Approximately seven
N			X	
O			X	
P			X	
Q	X			Three times
M			X	
R	X			Too numerous to call

5. Do these false targets have an adverse effect on the following:

a. Tracking a primary target?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M		X		
N			X	
O			X	
P			X	
Q		X		
M			X	
R		X		

b. Identifying a primary target?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M		X		
N			X	
O			X	
P			X	
Q			X	
M		X		
R		X		

c. Providing traffic advisories?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M		X		
N			X	
O			X	
P			X	
Q			X	
M		X		
R		X		

d. Overall control of air traffic?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M		X		
N			X	
O			X	
P			X	
Q			X	
M		X		
R		X		

6. Could you recognize false targets caused by terrain and sea clutter?

Controller	Yes	No	Not Observed	Comments
A		X		There appeared to be more primary targets in NAS (ARSR-3) than in DARC (ARSR-4)
B		X		
C		X		
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M			X	
N			X	
O			X	
P			X	
Q		X		
M			X	
R		X		

7. Could you recognize false targets caused by vehicular traffic and angels?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K			X	
L			X	
M			X	
N			X	
O			X	
P			X	
Q			X	
M			X	
R			X	

8. Could you recognize false targets caused by distributed precipitation?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G				
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M			X	
N			X	
O			X	
P			X	
Q		X		
M			X	
R	X			Corresponds with known roads

9. Could you recognize false targets caused by cellular precipitation?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G			X	
H			X	
I			X	
F			X	
J			X	
K		X		
L			X	
M			X	
N			X	
O			X	
P			X	
Q		X		
M			X	
R		X		

PRIMARY RADAR ACCURACY

Did the ARSR-4 provide the information needed for the following:

1. To adequately separate two aircraft?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			
G			X	
H			X	
I			X	
F			X	
J			X	
K	X			
L			X	
M	X			
N			X	
O			X	
P			X	
Q			X	
M	X			
R	X			

2. Radar vectoring?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			
G			X	
H			X	
I			X	
F			X	
J			X	
K	X			
L			X	
M	X			
N			X	
O			X	
P			X	
Q			X	
M	X			
R	X			

3. To determine when an aircraft was clear of an obstruction?

Controller	Yes	No	Not Observed	Comments
A	X			
B		X		
C		X		
D	X			
E		X		
F			X	
G			X	
H			X	
I			X	
F			X	
J			X	
K	X			
L			X	
M	X			
N			X	
O			X	
P			X	
Q			X	
M	X			
R	X			

4. To observe a target coincidental with the aircraft's known position?

Controller	Yes	No	Not Observed	Comments
A			X	
B	X			
C	X			
D			X	
E		X		
F			X	
G			X	
H			X	
I			X	
F			X	
J			X	
K	X			
L			X	
M	X			
N			X	
O			X	
P			X	
Q			X	
M	X			
R	X			

5. To determine range and azimuth of a target?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			
G			X	
H			X	
I			X	
F			X	
J			X	
K	X			
L			X	
M	X			
N			X	
O			X	
P			X	
Q			X	
M	X			
R	X			

6. To determine target degradation in the presence of clutter?

Controller	Yes	No	Not Observed	Comments
A			X	Don't know what this means
B	X			
C	X			
D	X			
E		X		
F			X	
G			X	
H			X	
I			X	
F			X	
J			X	
K	X			
L			X	
M	X			
N			X	
O			X	
P			X	
Q			X	
M	X			
R	X			

7. Provide for the control and separation of air traffic?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F			X	
G			X	
H			X	
I			X	
F			X	
J			X	
K	X			
L			X	
M	X			
N			X	
O			X	
P			X	
Q			X	
M	X			
R	X			

RANGE AND AZIMUTH RESOLUTION

1. From the demonstration, could you distinguish between two beacon targets that were at the same azimuth and separated by 5 nm?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			

2. Did you observe any beacon code or data block swapping?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		

3. What was the closest distance observed between two beacon targets (AT DIFFERENT ALTITUDES) at the same range before they merge?

Controller	Yes	No	Not Observed	Comments
A			X	
B				
C				1.5 mile
D				less than 1 mile
E				1 mile
F				1 mile

4. Did this demonstration verify that you were able to meet or exceed operational separation requirements?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			

BTP CODE VALIDATION AND ACCURACY

1. Did you always observe a correct response when a target squawked ident?

Controller	Yes	No	Not Observed	Comments
A			X	
B	X			
C	X			
D	X			
E	X			
F	X			

2. Did you observe the correct beacon code for each target displayed?

Controller	Yes	No	Not Observed	Comments
A	X			
B	X			
C	X			
D	X			
E	X			
F	X			

3. Did you observe any incorrect responses when a target squawked ident?

Controller	Yes	No	Not Observed	Comments
A			X	
B		X		
C		X		
D		X		
E		X		
F		X		

4. Did you observe any incorrect beacon codes for the targets displayed?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		

BTP SPLIT AND FALSE REPORTS

1. Did you observe any beacon splits during this demonstration?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D	X			Four
E		X		
F		X		
G	X			six or seven
H		X		
I	X			three
F		X		
J	X			twenty
K		X		
L		X		
M		X		
N	X			one - 20 miles east of blh on the 083 radial I observed one split beacon. The number of beacon splits would be acceptable to me as a controller. I observed what seemed to be fewer beacon splits and track jumps than what is normal.
O	X			Thirteen
P		X		
Q	X			Nine
M		X		
R		X		

2. Did you observe any false beacon reports?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G	X			Three or four
H		X		
I		X		
F		X		
J	X			One
K		X		
L		X		
M	X			Seven
N		X		
O		X		
P		X		
Q		X		
M	X			Twenty Five
R		X		

3. Did you observe any false emergency reports (7500, 7600, or 7700 codes)?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D		X		
E		X		
F		X		
G		X		
H		X		
I		X		
F		X		
J		X		
K		X		
L		X		
M		X		
N		X		
O		X		
P		X		
Q	X			
M		X		
R		X		

WEATHER DETECTION AND PROCESSING

1. Did you observe the two levels of weather information?

Controller	Yes	No	Not Observed	Comments
A		X		
B		X		
C		X		
D	X			
E		X		
F		X		
G	X			But they were false
H			X	
I	X			
F		X		
J		X		But I did observe a single line of weather without the HHH or other symbols.
K		X		
L			X	
M	X			
N	X			
O	X			
P			X	
Q	X			
M	X			
R	X			Erroneous north of BZA

2. Were you able to distinguish between the different levels?

Controller	Yes	No	Not Observed	Comments
A			X	
B			X	
C	X			
D			X	
E			X	
F			X	
G	X			But they were false
H			X	
I	X			
F			X	
J			X	
K		X		
L			X	
M	X			
N	X			
O	X			
P			X	
Q	X			
M	X			
R	X			

3. Was the weather contour well defined?

Controller	Yes	No	Not Observed	Comments
A			X	
B			X	
C			X	
D	X			
E			X	
F			X	
G			X	
H			X	
I	X			However it was false
F			X	
J			X	
K	X			
L			X	
M	X			
N	X			
O			X	
P	X			
Q	X			Same as other displays
M	X			
R			X	